SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1913.

GENERAL PHYSICS.

1757. *New Electric Pendulum.* **M. Schanzer.** (Zeitschr. Instrumentenk. 33. pp. 218–223, July, 1913.)—Describes a new form of apparatus for electrically maintaining the motion of a pendulum. The energy consumption is very small, only 8 milliwatts ; and the ratio of the length of arc during which the pendulum is driven, to the whole swing, is about 1 : 18, the pendulum thus swinging freely for the greater part of its motion. The pendulum itself is a quartz rod 110 cm. long and 1·8 cm. diam., so that there is only a small variation of length with temperature. The whole apparatus can be enclosed, so that the pendulum can swing *in vacuo* if required. For details of the mechanism see diagrams in original paper. A. W.

1758. *Small Hydraulic Testing Machine.* **Genès.** (Rev. de Métallurgie, 10. pp. 1142–1146, Sept., 1913.)—Describes, with illustrations, the Schiller testing machine. This is an hydraulic apparatus, with a hand-worked oil pump, the load on the plunger (and hence on the test-piece) being indicated by pressure gauges, one of which has a range of 10 tons and is automatically shut off at that pressure, whilst the other reads up to 50 tons. Compression is obtained between the plunger-head and the inside of the principal framework, which is of the form of a chain link. Ball-impression hardness tests are made in the same way, with the addition of a suitable ball-holder. For tensile tests another framework is added, and tension is obtained between the principal frame and the crossbar of the added frame. Tests upon a ring-shaped test-piece appear to have been primarily considered in the design of the machine. The ring surrounds two saddles formed upon the sides of the plunger-head and cylinder respectively. An extension indicator provided with the machine is sensitive to 1/1000 mm. The writer points out that this form of extensometer only indicates the elastic limit by the method of loading and unloading, and noting whether any permanent set has occurred or not ; also he remarks that the frame supplied for tensile tests is too long for ordinary short tensile test-pieces, as it takes a minimum tested length of 10 in. The compactness of machines of this kind, and the adaptability of the present machine to a variety of kinds of testing are its principal merits. F. R.

1759. *Experiments with a Tilting Manometer for Measurement of Small Pressure-differences.* **J. R. Pannell.** (Engineering, 96. pp. 343–344, Sept. 12, 1913.)—The pressure-gauge itself was originally designed by A. P. Chattock [Abstract No. 848 (1901)], and the writer gives some notes in the present paper on its behaviour, and on some improvements which he has made. The gauge consists of a glass U-tube of somewhat unusual form, mounted on a metal tilting frame, photographs of which are given. The pressure-difference is measured by tilting the U-tube instead of measuring the vertical displacement of the surface, errors due to capillarity being thus avoided. Full details of the apparatus are submitted, and the method of using the gauge described with such precautions as are necessary. The gauge is sensitive to a pressure-difference of 0·00006 in. of water, or 0·000002 lb. per sq. in. This head would represent less than 1 % on the velocity of a current of air at 0·4 ft. per sec., as calculated from the pressure in a Pitot tube. The fluids employed in the gauge were pure castor oil and distilled water, but trouble was experienced due to the clouding of the oil. This cloud gradually developed, rendering the gauge very unsensitive, and finally making it impossible to observe the position of the separation surface. After trial of a considerable number of different combinations it was decided that pure castor oil and a solution of ordinary bar salt in distilled water gave the best results. The high viscosity of castor oil is not usually an objection, but where it is, pure benzine can be substituted, though the gauge would be a little less sensitive. Solutions with specific gravities varying from 1·001 to 1·07 were tried, and the 1·07 solution was decided on as the most suitable. Time-sensitivity curves are given, and show that the sensitivity of the castor-oil water-gauge falls off very rapidly. An interesting fact was disclosed in that after the gauge had been subjected to a low temperature for 32 days its sensitivity increased with rise of temperature due to the fact that at low temperatures the clouding condition causes loss of sensitivity. Height-sensitivity curves for three gauges of different dimensions are also given, and show the gauge to be most sensitive with a moderately high bubble—a result confirmed by a mathematical investigation of the subject by Jones, of Madras. Modifications of the gauge finally receive attention. H. H. Ho.

1760. *Seismographic Apparatus.* **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 665–676, June 15, 1913.)—Observations are recorded as made with two instruments of the author's type for vertical movements, using galvanometric registration. A plate is given showing the character of the very open record. C. P. B.

1761. *Method of Increasing and Controlling the Period in Vertical-motion Seismographs.* **F. A. Perret.** (Amer. Journ. Sci. 36. pp. 297–300, Sept., 1913.)—To obtain a satisfactory vibration period in seismographs for recording vertical motion, the designers of such instruments are generally under the necessity of employing, for the suspension of the weight, a long and sensitive spring under strong tension. The use of such a spring, however, introduces a very serious defect in the practical working of the instrument, viz., a lack of stability in the position of rest due to the effect upon the spring of variations of temperature. The result is a continual wandering of the recording lever from its normally central position, which cannot be obviated by even the most ingenious compensating devices. Furthermore, there is the inherent difficulty of the large amount of spring required, whereby any slight alterations are magnified sevenfold. It occurred to the author that the variations of a magnetic field—due to relative motion of the parts of an instrument in action—might be utilised as a counter-influence to the action of a coarse and stiff spring, thus permitting the use of one so short and robust as to be free from extreme sensitiveness to temperature and other variations. The details of the apparatus, which is still in the experimental stage, are then carefully described. Anticipating a possible criticism, the writer states that he cannot believe any variations of terrestrial magnetism or action of telluric currents at the time of an earthquake could adversely affect his apparatus. So far the author has only applied magnetic control to seismographs for vertical motion, but it is conceived that, in many cases, a horizontal pendulum would be the better for a more positive self-centring factor in the pendulum *per se*, the period then being increased to any desired value by the magnetic control. H. H. Ho.

1762. *Horizontal Flexure of Meridian Instruments.* **B. Baillaud.** (Comptes Rendus, 157. pp. 193–196, July 21, 1913.)—A method of determining the flexure of meridian instruments is outlined, involving the measurement of collimation readings of the eyepiece micrometer and circle for a series of multiple reflections from a plane mirror and mercury bath, the line of intersection of the two reflecting surfaces being adjusted perpendicular to the meridian. The method is to be tried with the large meridian circle at the Nice Observatory. C. P. B.

1763. *The Molecular Air-pump.* **W. Gaede.** (Ann. d. Physik, 41. 2. pp. 337–380, June 3, 1913.)—The pump itself has been described in Abstract No. 1608 (1912), and little additional information is here given; the second part of the paper, however, deals with certain points in the kinetic theory of gases. Some confirmation of the correctness of the view that the action of the pump depends upon molecular movements is afforded by temperature measurements conducted by the author. As the temperature of a gas depends upon the velocity of the molecules, a thermal kinetic effect should be observable in the molecular pump corresponding to its hydrodynamic effect, even if no temporary variations of pressure occur. When the cylinder [see Fig. in Abstract No. 1608 (1912)] rotates clockwise, the gas molecules should strike the upper surface of C with increased velocity, and the lower surface with diminished velocity, and the upper surface should become warmer than the lower surface. By the aid of a thermo-couple these kinetic heat-differences were actually proved to exist so soon as the pressure was sufficiently low to allow the free paths of the moving molecules to become larger than the dimensions of the groove; this takes place when the pressure sinks below 0·001 mm. At this pressure the volume of air removed per sec. has its max. value of 1380 cm.^{3}. This kinetic heat effect, the author points out, is meteorologically interesting. A meteorite passing through the upper atmosphere is under the reversed conditions of the blade C, because the meteorite rushes at great speed through the relatively stationary air molecules, whilst in the pump the blade is at rest and the molecules are being rushed. Accepting the meteorological data of Wegener, the author calculates that temperatures of about 5000° and 8000° C. would be attained by meteorites at altitudes of 100 km. and 200 km. respectively, owing to the kinetic heat effect. L. H. W.

1764. *The Large Comparator of the German Imperial Standards Verification Commission.* **W. Kösters.** (Zeitschr. Instrumentenk. 33. pp. 238–247, Aug., 1913.)—Illustrated description.

1765. *Simple Comparator for Testing of End-gauges up to Five Metres in Length.* **W. Breithaupt.** (Zeitschr. Instrumentenk. 38. pp. 226–227, July, 1918.)

1766. *Gyroscope Mechanism.* **J. W. Gordon.** (Engineering, 96. pp. 275–277, Aug. 29, 1918.)—Describes an arrangement by which the gyroscope may be used to turn an applied *moment of force* through a right angle as a bell-crank lever turns a force through a right angle. E. H. B.

1767. *Measurement by Radio-telegraphy of the Difference of Longitude between Paris and Washington.* **B. Baillaud.** (Comptes Rendus, 157. pp. 165–171, July 21, 1918. Lumière Électr. 23. pp. 205–208, Aug. 16, 1918.)—This is a report presented to the Academy of Sciences of the results obtained by a French Mission under the direction of Renaud and Bourgeois. The radio-telegraphic stations at the Eiffel Tower and at Arlington were respectively utilised. The astronomical observations were made with the prismatic astrolabe and chronometer. The radio-telegraphic comparisons were made during the observations by a third operator who had to compare his chronometer with those of the Marine and War Departments, which made separate observations, by the method of coincidences. To these three groups at each station was added at Arlington the photographic registration of the signals. The radio-telegraphic comparisons were made by means of 300 signals constituted of lines of half a second of which the commencements, spaced regularly about (1—1/120 sec.), properly speaking, formed the signals. The two stations sent alternatively like signals by groups of four. Of the dozen series of trials three were absolutely fruitless owing to disturbances by extraneous transmissions; five were partially satisfactory; but only the series of March 28 and April 1 were completely satisfactory on both sides. These have permitted of sufficiently precise determination of the duration of the time of transmission between the two stations, distance 6175 km. The values obtained for the double of this duration were respectively 0·066 sec. and 0·063 sec. The last was adopted as being the most trustworthy. The observations of the War Department made the corresponding value to be 0·04 sec. The difference of personal equation between the two observers of the Marine Department respectively at Paris and at Washington was determined by a series of observations comprising 60 stars. It was found to be 0·065 sec. Making allowance for the above and other possible sources of error which are referred to in the report, the new determination of the difference of longitude (1913) is larger by 0·046 sec. than the old. Regarding the photographic registration of the signals at Arlington, experience showed that the rhythmic signals from Paris were sufficiently intense and could be distinguished from atmospheric disturbances except when the latter were very strong. E. O. W.

1768. *Stretching and Breaking of Sodium and Potassium.* **B. B. Baker.** (Phys. Soc., Proc. 25. pp. 235–238; Discussion, p. 238, June, 1913.)—When stretched, wires of sodium or potassium do not collapse to a point or break off suddenly, but collapse from two opposite sides into a chisel end, just as Andrade found with wires of solid mercury. Further, when the sodium or potassium wire is prepared by allowing the molten metal to solidify in a narrow glass tube and removing by means of a rod, it exhibited when stretched two sets of equidistant, encircling rings, crossing one another and lying in planes, making an angle of about 45° with the axis of the wire. Members of the two sets touch along the line of greatest thinning and bisect each other along the line where no thinning occurs. As the wire is stretched to the breaking-point, the rings become more clearly marked but remain unchanged in position or slope. One set of rings is usually much more distinct than the other. Mercury wires also exhibit two sets of rings, which are here very much finer and closer together than with sodium or potassium. These wires thus appear to exhibit the behaviour of plastic metals in one direction and that of brittle metals in the perpendicular direction. The author suggests that the portions of the metal brought into play are in the form of cubes, which, when placed so that a plane through two opposite edges is parallel to the axis of the wire, would allow of lateral contraction by faces sliding one over another in one direction only and not in the direction at right angles.

T. H. P.

1769. *Density of Aluminium.* **F. J. Brislee.** (Faraday Soc., Trans. 9. pp. 162–173, July, 1913. Engineering, 95. pp. 780–781, June 6, 1913.)—Numerous determinations show that generally the density of aluminium is increased by annealing and decreased by cold working; the following are some examples, each the mean of several determinations [see also Abstract No. 1308 (1912)]:—

Condition of Aluminium.	Density.
As cast	2·7059 ± 0·00044
Same, annealed 14 hours at 450°	2·7080 ± 0·0002
Same, annealed twice „	2·7067 ± 0·0002
Same, annealed 8 times „	2·7060 ± 0·0002
Wire, hard drawn	2·7026 ± 0·0004
Same, annealed at 450°	2·7057 ± 0·0005
Sheet, as rolled cold	2·7076 ± 0·0002
Same, annealed 2 hours at 560°	2·7086 ± 0·0002
Same, annealed 22 „	2·7085 ± 0·0001

Several photomicrographs show the structures of the samples. The ingot as cast or annealed is polyhedric; so also is the worked and annealed metal. The structures of the cold-worked samples were apparently amorphous, but the hot-worked metal showed elongated grains. It is considered that the density changes agree with the theory of the production of the amorphous state. The return to the crystalline condition by annealing is relatively slow.

F. R.

1770. *The Transition from the Elastic to the Plastic State in Mild Steel.* **A. Robertson** and **G. Cook.** (Roy. Soc., Proc. Ser. A. 88. pp. 462–471, July 1, 1913.)—The sudden extension of the test-piece and the accompanying drop of the beam of the testing machine, indicates that some reduction of the stress in a specimen of mild steel takes place at the yield-point. An arrangement has been designed ensuring axial loading and limiting the extension after yield by causing the load to be taken jointly by the test-piece (⅜ in. diam.), and two bars of mild steel (¾ in. diam.). Extensometers were attached to the latter, so that the load occurring in them at any time was determinable. When the specimen yielded, an increased load was taken up by the two bars from which increase the percentage reduction of stress in the test-piece before and after yield was calculated and found to be as high as 36 and as low as 17. In the majority of cases (9 in 12), however, the values ranged from 24 to 30. These variations are ascribed to (1) slight deviation from truly axial loading, and (2) slight variations in composition or heat treatment of the material. A test made with a modified Martens' extensometer indicates that the "drop" is a phenomenon associated with the breakdown from the elastic state, and that the reduced stress remains at a fairly constant value over a total strain equal to several times the magnitude of the elastic strain. The case of non-uniform stress was also studied in bending and torsion. In bending the reduction of stress lies between 25 and 33 per cent., while in torsion it is probably somewhat greater than 25 per cent. F. C. A. H. L.

1771. *Flow of Anisotropic Liquids in a Magnetic Field.* **M. W. Neufeld.** (Phys. Zeitschr. 14. pp. 646–650, July 15, 1913.)—Since, according to Bose's swarm theory, anisotropic crystals set themselves parallel to a magnetic field, and should experience less viscous resistance to flow when pointing along a capillary tube, the author examined the capillary flow of anisaldazin and *p*-asoxyanisol in a magnetic field under pressures of 9 cm. and 51 cm. Hg. No effect of the magnetic field could be observed. This indicates that Bose's swarms are much smaller than hitherto thought. That being so, a new explanation of the connection between pressure and outflow must be sought. E. E. F.

1772. *Stationary Flow of Compressible Fluids.* **O. Janzen.** (Phys. Zeitschr. 14. pp. 639–643, July 15, 1913.)—A theoretical investigation of the resistance of air when it can no longer be regarded as incompressible. A cylinder is placed in a uniform current with its axis normal to it. It is shown that up to velocities of some 100 m./sec. the compressibility of the air exerts very little influence upon the stream-lines; but this influence increases with the square of the speed. The cylinder experiences no resistance to its motion except that due to viscosity. The method used by the author is that of the velocity potential. The same method can be used for the solution of other problems concerning compressible fluids when the solution for incompressible fluids is given. E. E. F.

1773. *Distribution of Stress due to a Rivet in a Plate.* **E. G. Coker** and **W. A. Scoble.** (Inst. Naval Architects, Trans. 55. pp. 207–218, 1913, Engineering, 95. pp. 439–442, March 28, 1913.)—A further application of the author's photoelastic method of investigation [see Abstract No. 906 (1913)]. L. H. W.

1774. *Reflection of Shearing Deformation at the Boundary of Two Liquids.* **A. Finzel.** (Deutsch. Phys. Gesell., Verh. 15. 15. pp. 645–657, Aug. 15, 1913.)—A theoretical investigation followed by an experimental examination of the reflection with mercury and with glycerine; approximate agreement between theory and experiment being found. L. H. W.

1775. *Oscillations about a Position of Equilibrium.* **H. J. E. Beth.** (Phil. Mag. 26. pp. 268–324, Aug., 1913.)—Mathematical.

1776. *Two-dimensional Motion of a Frictionless Liquid.* **W. B. Morton.** (Roy. Soc., Proc. Ser. A. 89. pp. 106–124, Aug. 19, 1913.)—A theoretical paper which should be referred to in the original.

1777. *Distribution of Wind Velocity about a Circular Rod.* **J. T. Morris.** (Engineering, 96. pp. 178–181, Aug. 8, 1913.)—Describes investigations made with a hot-wire Wheatstone-bridge apparatus. The results obtained are illustrated by elaborate polar curves which show the forward cushioning and rear screening influence of the rod in a transverse wind current near the surface of the rod. These influences tend to disappear as the distance from the rod increases. The original article should be consulted, as the diagrams are not suitable for reproduction. C. A. B.

1778. *Structure of Diamond.* **W. H. Bragg** and **W. L. Bragg.** (Nature, 91. p. 557, July 31, 1913.)—The authors have applied the new methods of investigation involving the use of X-rays to the case of the diamond, and have arrived at the knowledge of its structure, which is extremely simple, as follows:—Every carbon atom has four neighbours at equal distances from it and in directions symmetrically related to each other. The directions are perpendicular to the four cleavage or (1.1.1.) planes of the diamond; parallel, therefore, to the four lines which join the centre of a given regular tetrahedron to the four corners. The elements of the whole structure are four directions and one length, the latter being $1{\cdot}52 \times 10^{-8}$ cm. If the structure is looked at along a cleavage plane it is seen that the atoms are arranged in parallel planes containing equal numbers of atoms, but separated by distances which alternate and are in the ratio 3 : 1 (viz. 1·52 and 0·51 each $\times 10^{-8}$ cm.). It is a consequence of this arrangement that no second-order spectrum is reflected by the (1.1.1.) planes, although spectra of the first, third, fourth, and fifth orders are found. It was this fact that suggested the structure here described. Several tests may be applied and all are satisfied.

Zincblende appears to have the same structure, but the (1.1.1.) planes contain alternately only zinc and only sulphur atoms. In this way the crystal acquires polarity and becomes hemihedral. E. H. B.

1779. *Formation of Molecules from Thomson's Atoms.* **A. C. Crehore.** (Phil. Mag. 26. pp. 25–34, July, 1913.)—The equilibrium configurations for various numbers of electrons, as calculated by J. J. Thomson, are such as would result from the assumption that electric force is propagated with infinite speed instead of with the speed of light. The investigations here considered, however, lead the author to believe that this assumption will not essentially modify the configurations, while it greatly simplifies the formulæ. It is therefore adopted by the author, together with the assumption that the rings of electrons are true circles. The experimental evidence, however, suggests that they are not true circles, except in combinations containing only a single ring, but only approximately circular. If this is a fact, the theoretical difficulties are increased. To use such atoms as a basis for calculating the molecules of compounds we must know the relative radii of the orbits of the various electrons, and their exact equilibrium positions. The author attempts to obtain these data approximately by means of experimental models of atoms in which all the electron orbits are in the same plane. The difficulties of the solution almost necessitate this assumption, and the results seem to indicate the probability of its being the actual arrangement. The equilibrium configuration being experimentally obtained and measured, the electrostatic forces between them are calculated, and to these are then added the separately calculated forces brought into play by the orbital motions.

The author states the experimental problem to be solved as follows:—"Given a number of equal bodies confined to one plane and perfectly free to move in that plane without friction, where will each come to rest in stable equilibrium if we suppose that they are acted upon by forces obeying two different laws? First, that each body is attracted toward one common centre by a force proportional to its displacement from that centre; and second, that each of the bodies repels each of the others by a force inversely proportional to the square of the distance between them. These are the assumptions made with reference to the electrons within the sphere of positive electrification of the atom." In the floating magnet figures these conditions are obviously very imperfectly fulfilled, and the central rings are found to form sooner, as magnets are added, than as calculated. The author replaces the magnets by electrostatically charged spheres of steel or Al turned to uniform gauge with the greatest accuracy attainable. The spheres were suspended from fine copper wires, or from silk fibres moistened with glycerine, and charged to between 5000 and 10,000 volts. A storage battery would have been the ideal source: the actual method employed was connection, by means of a synchronous motor, to alternating potential at selected points of its phase, with condenser charged and discharged at each cycle, the rapidity of succession being such as to make the application of the power in effect continuous. The spheres were immersed in castor oil, having the specific inductive capacity 4·7, and which is, moreover, viscous at ordinary temperatures, and therefore prevents oscillation. It is also quite transparent, which is advantageous for securing photographs. The figures were then controlled so as to make them agree with the calculated ones, the method finally adopted for control being to surround the whole system by an iron-wire screen 80·5 cm. in diam. and 53 cm. high resting upon a flat steel plate, the distance of which below the spheres was adjustable. With a single ring the charges will, from symmetry, be equal. With more rings the relative charges should be measured, but this has not yet been done. Photographs and interesting curves of experimental results are given, serving by their smoothness to test, in a measure, the experimental work. Take, *e.g.* the curve through the stable combinations 6–4, 7–4, 8–4, 9–4, 10–4, showing a systematic law of change, jumping suddenly, for 15 electrons, to the next broken line.

To indicate calculation procedure consider a pair of atoms, each containing two electrons within a positive sphere, placed with the axes of their orbits coincident, and their planes parallel, with the electrons in phase, all lying in the same meridian plane. A series is then obtained giving the electrostatic force between the atoms as a function of the distance; and the total force, controlled by the principal term, is found to be a repulsion varying as the inverse sixth power of the distance. The revolution of the electrons around the common axis gives rise to an attraction, superimposed on the repulsion, and varying as the inverse fourth power of the distance. At the balancing point the equilibrium is found to be unstable, and the fixed distance at which stable equilibrium is finally attained depends on the orbital speed, and is probably many times greater than the radius of the orbits. This distance between the atoms may be regarded as of the order of magnitude of the dimensions of molecules, which are therefore of an entirely different order of magnitude from the atoms of which they are composed. With increasing distance the electrostatic attraction will become less than the gravitational attraction varying as the inverse square. There is, therefore, a second critical distance, accounting for the existence of the *molecular range*, at which the law of gravity changes. In calculating the forces between the atoms, the atoms are assumed to remain sensibly at a constant distance during several revolutions of the electrons in each, and so expressions are obtained for the instantaneous values of the four component forces as functions of the time. These are resolved along the line joining the centres of the orbits; perpendicular to this line in the plane of the meridian of e; and perpendicular to each of these directions along the circle of latitude. The averaging of the first of these components over a long period of time gives the attraction, or repulsion, along the line of centres, which the two electrons contribute to the force between the atoms. When two atoms are in equilibrium forming a molecule it is shown that if their electrons are displaced a little from a fixed phase relation, the moment of the forces tends to return them to their original phase relation, and they are again in phase equilibrium. The author considers that if the periods are nearly the same they will become synchronised during the process of forming a stable molecule, so that the solution of the equations on the assumption of equal angular velocities is of primary importance. The parallelism of the orbital planes is a condition of stable equilibrium. If the axis of rotation is slightly disturbed, there are forces tending to return it to parallelism, and at the same time giving the whole system all the effects of gyroscopic motion, but of a peculiarly modified character arising from the flexibility of the rings of the electrons. The methods of extending the calculations to rings of many electrons are dealt with.

For three atoms in a molecule there are shown to be at least two stable positions differing in degree of stability, and one case is calculated with four atoms in the molecule. This might represent a ring of three hydrogen atoms with one nitrogen atom at the apex of the right cone of which the ring forms the base. The addition of another atom increases considerably the distances necessary for equilibrium, and a case calculated might represent carbon with a ring of four hydrogen atoms. If nitrogen, oxygen, fluorine were successively substituted for carbon, the distances would increase for each substitution, so that the carbon compound would be the most stable, and the fluorine compound the least stable of the series. Even in the first case, however, the dimensions seem too great for the long-continued existence of the molecule, but if two of the hydrogen atoms are removed from the upper to the lower ring of the carbon atom, the distance between the carbon and hydrogen atoms is almost halved. The substitution of nitrogen for carbon in this case would give rise to methane, or marsh gas, with somewhat less stability.

The series obtained not being convergent does not give the force close to an atom, so as to show what becomes of a charge drawn towards an atom, thus forming an ion. The equations show, however, that it is false to assume that the charge in an atom has an effect equivalent to that of the same charge at the centre of the sphere; neutral atoms can, therefore, attract or repel, and it becomes unnecessary to assume the loss or gain of electrons by an atom in order to account for these actions. Moreover, with a Thomson atom, containing a small number only of electrons, the loss or gain of an electron could hardly be imagined as taking place without completely changing the character of the atom.

With respect to the possibility of accounting for gravitation by the electric forces the author points out that the only way as yet found to obtain terms with the inverse square of the distance is by the assumption of synchronous revolution of the electrons at a great distance apart. The probabilities against such synchronous motions are very great, except at molecular distances, when a rigid connection has been established between the atoms of a molecule. It was found, however, that the orbital motions of the electrons must depart somewhat from circularity; and whether or not any terms may be found, due to the gyroscopic motions of the atoms, that will give rise to a force varying as the inverse square of the distance is worth investigating. G. W. de T.

1780. *Spectroscopic Resolution of an Arbitrary Function.* **C. V. Burton.** (Phys. Soc., Proc. 25. pp. 245–251; Discussion, pp. 251–252, June, 1918.)—An ordinary grating has periodic rulings, and a spectrum obtained by means of it is characteristic of the radiation entering the spectroscope slit. But if the radiation is homogeneous, while the distribution of the rulings is arbitrary, we obtain a spectrum characteristic of the grating. It is thus found to be theoretically possible to resolve spectroscopically a given arbitrary function into its harmonic constituents. The "permeability" of a photographic negative at any point being defined as the square root of the reciprocal of the "density," the first step is to make an "equivalent grating." This is a plate whose permeability (variable in one dimension only) has at any point x the value $A + B\phi(x)$, where A and B are constants. When this (transmission) grating takes its place in a spectroscope whose slit is fed with homogeneous light, the spectrum of the function $\phi(x)$ can be seen or photographed. Suitably interpreted, it gives us the periodogram of $\phi(x)$. A device is described which, it is hoped, may prove useful for determining the phases of the various harmonic constituents. The theory of the proposed method of resolving functions is discussed, and is as complete as that of ordinary spectroscopy, while in one respect it is more simple; for, since the light entering the spectroscope slit is entirely of one wave-length, the comparison of intensities of spectral lines (whether visually or photographically) is facilitated. Some preliminary practical tests are now being made. In the *discussion*, the author stated that he thought Rayleigh's method [Abstract No. 1868 (1908)] had great advantages. Also (in reply to **Sears**) that the present method gave the periodogram of a function as it was given by Fourier's double integral theorem, and, in analysing a column of numerical values, the method would give all the detail that was actually involved in the figures themselves. **Eagle** made reference to the analysis of a function extending over a limited range into the ordinary Fourier's series, pointing out that it would be necessary to repeat this function end to end a very large number of times in the grating. A. W.

1781. *Isostasy in the Alps.* **A. Prey.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2467–2518, Dec., 1912.)—A long discussion is given of the gravitational distribution, based on observations in the Tyrol, with tabular summaries of the densities and widths at eighteen selected longitudes, and groupings of the formations with their mean elevations. C. P. B.

1782. *Suspension of Particles in Air Eddies.* **W. Schmidt.** (Meteorolog. Zeitschr. 30. pp. 171–174, April, 1913.)—Small particles under the action of gravity fall through still air with a velocity which does not exceed a value that is determined from Stokes' formula. If the air is rotating uniformly like a solid about an horizontal axis, the motion of a falling particle relative to the air is such that its direction of motion changes uniformly, *i.e.* the relative path is a circle. The time taken in describing the circle is equal to the time of a complete revolution of the air, and it thus follows that the *actual path* of the particle is a circle with its centre at a point distant horizontally from the centre of the vortex by an amount equal to the radius of the *relative* path. In consequence of the vortex motion the particle though continually falling with regard to the adjacent air, is in this way kept continually within the vortex, provided the latter does not change in position or intensity beyond certain limits. This is adduced as a possible explanation of the retention in the air of the small droplets of water which form clouds and also of the growth of successive layers of ice around hail-stones, it being considered that the growth takes place during the time that the newly formed stone is retained within the boundary of a vortex of air of suitable intensity.

R. C.

1783. *Theoretical Computation of Temperature-distribution in the Free Atmosphere on Occasions of Föhn.* **F. Pockels.** (Meteorolog. Zeitschr. 30. pp. 216–222, May, 1913.)—This is a mathematical discussion of the form of stream-lines over obstacles of suitable mathematical shape which are not dissimilar in their main outlines to mountains; and a computation of the rate of fall of temperature over different portions of the obstacles. An interesting result is that the deflection of the stream-lines in the air flowing over an obstacle is not confined to the lowest layers, but extends upwards to very considerable heights. R. C.

1784. *Simultaneous Interdiurnal Changes of Pressure and Temperature on the Sonnblick and at Salzburg, with Remarks on Aperiodic Fluctuations of Pressure.* **J. v. Hann.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 45–136, Jan., 1913.)—Salzburg lies about due north of Sonnblick at a distance of 83 km. The heights above sea-level are respectively 431 m. and 3105 m. Since changes of weather usually come from the west they affect both places nearly simultaneously, so that on the average the horizontal distance between the stations may be disregarded and they may be supposed to be in vertical line as regards changes of pressure and temperature. The mean change of pressure from one day to the next (interdiurnal variation), may be expressed by computing the means of the positive and negative changes separately. On the Sonnblick both of these quantities are about 2¼ mm.; the negative being slightly larger than the positive. At Salzburg the quantities are about 3¼ mm. The ratio between the values for the two stations agrees well with the theoretically computed ratio. For temperature the corresponding interdiurnal changes are on the mean for the year 2·54° C. for the Sonnblick and 2·38° C. for Salzburg. In 62 % of the total number of cases agreement is noted between the signs of the interdiurnal temperature-changes at the two stations. The percentage frequency of pressure-changes of like sign is 72 %. An examination is made of the 28 % of cases where the pressure variations are of opposite sign, and it is seen that when an increase of pressure at the summit synchronises with a decrease at the base the temperature of the whole column is rising; on the other hand, when the pressure is decreasing above and increasing below the temperature of the whole column of air is falling. A striking table shows that during the course of an increase of pressure extending over 2 or 3 days, temperature on the Sonnblick rises 1·40° C. on the first day on the average and as much as 2·2° C. on the second day; conversely a continuous fall of pressure is associated with a temperature fall of —2·1° C. on the Sonnblick during the first day and —2·9° C. during the second day. At Salzburg a pressure-increase or -decrease is associated with a fall or rise of temperature respectively on the first day, as may be expected, while the temperature-changes on the second day are irregular. Falls of temperature in connection with line-squalls and thunderstorms frequently extend to the Sonnblick but with diminished intensity. The author combats the old generalisation that the barometer falls below a warm column of air and rises below a cold one, maintaining that temperature variations in the upper air follow the pressure variations so that the latter are probably the cause of the former. He also points out the great differences between the ratios of monthly variations of temperature and pressure in different parts of the globe. If pressure-changes depend only upon temperature-changes that ratio should be nearly constant, whereas it varies both with latitude generally and also with distance from the sea. The origin of cyclones and anticyclones is looked for in connection with disturbances in the great atmospheric currents rather than in the appearance of warm or cold masses of air in the higher layers. R. C.

1785. *Motion of Cirrus Clouds in Relation to the Movements of Barometric Minima.* **T. Hesselberg.** (Beitr. zur. Physik d. freien Atmosphäre, vol. 5. No. 3. Meteorolog. Zeitschr. 30. pp. 395–397, Aug., 1913. Abstract.)—A comparison between the paths of cyclones and the direction of motion of cirrus clouds shows that at any instant the two directions of propagation are very nearly the same. The ratio between the velocities of the barometric minimum and of cirrus clouds varies from 0·8 to 0·6 according as the pressure at the centre of the depression is very low or not, and it remains constant provided that this pressure does not vary. If the cyclone is becoming deeper the ratio varies from 0 to 0·2 ; it is larger than 0·6 if the depression is filling up. The direction of motion of cirrus cloud changes very slowly with the lapse of time, consequently it is possible to predict the direction of motion of a depression for 12 to 24 hours in advance from an observation of the direction of cirrus. R. C.

1786. *Studies on Line-squalls among Mountains.* **A. Roschkott.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2635–2666, Dec., 1912.)—Observations for these studies were derived from Innsbruck, situated in the valley of the Inn, and a number of stations on the surrounding Alps culminating with the mountain observatory on the Zugspitze (2964 m.). A comparison of barometer observations at the base and summit with the temperature observations at the stations on the mountain-side, show that before a squall the temperature of the free air over the valley is lower than that deduced from the observations at the stations. The surfaces of equal temperature therefore sink down from the mountain over the valley. After a squall the temperature-difference is much smaller and the surfaces of equal temperature are nearly horizontal. The lower layers are in unstable equilibrium before the squall ; afterwards they are in stable equilibrium, and the sudden increase of pressure at the surface, characteristic of a line-squall, is explained by the replacement of the unstable layers of air by a current of cold air which pushes beneath them. A computation gives the mean depth of the cold current over Innsbruck from the amount of pressure-increase as 670 m. Specific humidity in the surface layers increases after the passage of the squall. If the squall is accompanied by rain, specific humidity decreases in the upper layers after its passage, because part of the moisture falls out of the air in the form of rain. If unaccompanied by rain the passage effects an increase of specific humidity in the upper layers also. R. C.

1787. *Results of Observations of Temperature and Pressure in Baroma.* **J. Fényi.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2068–2078, Nov., 1912.)—Baroma is in South Africa on the south side of the Zambesi, about 300 miles from the Indian Ocean. Tables of hourly means (4 years) of temperature, frequency of temperature, and harmonic coefficients of diurnal variation of pressure and temperature in the different months of the year are given in detail, and the results are discussed. The observations were obtained from a small Richard thermograph and a Richard barograph, both of which were periodically set to agree with standards. R. C.

1788. *Results of Pilot Balloon Ascents at Vienna in Anticyclonic Weather.* **R. Dietzius.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2081–2117, Dec., 1912.)—The paper is based upon observations of 48 pilot balloons, each of which was followed to a height of at least 3000 m. The direction and magnitude of the barometric gradient is determined for each occasion from pressure observations made at the corners of a triangle which contained Vienna. Taking the ascents collectively, the mean angle between the wind in each ½ km. of height and the direction of the gradient is computed, the mean wind being obtained vectorially from the single observations. Finally the weather conditions which determine a right-handed or left-handed change of direction of the wind from 1500 m. to 3000 m. are examined. The change in direction is found to be connected in general with the direction of motion of barometric minima. R. C.

1789. *The Distribution in Height of Penetrating Atmospheric Radiation.* **E. Schrödinger.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2391–2406, Dec., 1912.)—The sources of the radiation are divided into three: (1) materials contained in the earth or precipitated upon its surface; (2) radio-active substances suspended in the air; (3) hypothetical cosmical sources. The last is introduced in case it is found that the first two are insufficient to account for the observed phenomena. The first source has been investigated quantitatively by Eve and King [Abstracts Nos. 862 and 864 (1912)], but the second has not hitherto been treated in this way owing to the lack of observations made in the free air. By a mathematical process it is concluded that the radiations from the earth and the air are probably of the same order of magnitude, although the former appears to exceed the latter. R. C.

1790. *Diminution of Solar Radiation in the Summer and Autumn of* 1912. **A. Schedler.** (Meteorolog. Zeitschr. 30. pp. 193–194, April, 1913.)—In order to compare the transparency of the sky to solar radiation in 1911 and 1912, all those sunshine records obtained at Innsbruck from a Campbell-Stokes sunshine recorder, which showed a continuous burn from morning to evening, were selected, and the times at which the burns commenced were plotted on squared paper as ordinates against the corresponding days of year as abscissæ, and successive points joined. Two curves, one for each year, were thus obtained, and a comparison between them shows that on clear days in 1912 the sun commenced recording from 20 to 40 mins. later than it did at the corresponding time for 1911 on most of the days from the end of June to the beginning of Nov. A similar result, but in the opposite sense, is shown by the corresponding curves for the times of cessation of the burns on clear days. Before June and after Nov. the curves for 1912 approximate to those of 1911. This indicates that the transparency of the sky during the summer and autumn of 1912 was less than that of 1911. R. C.

1791. *Diminution of Solar Radiation at Warsaw during 1912.* **L. Gorczyński.** (Comptes Rendus, 157. pp. 84–86, July 7, 1913.)—Continuous registration of solar radiation by an electrical compensating instrument has been made at Warsaw since Jan., 1901, and mean values of radiation for each month since that date have been computed therefrom in gm.-cals./(cm.² min.). These are represented in a table by means of differences from the means for the months. The diminution of radiation in 1912 is compared with that of 1902–1903. On the latter occasion radiation was continuously below the average from Nov., 1902, to Oct., 1903; on the former occasion the diminution of radiation extended from July, 1912, to Jan., 1913; the largest divergence from normal being in the month of September. R. C.

1792. *Amount of Annual Evaporation from Swiss Lakes.* **J. Maurer.** (Meteorolog. Zeitschr. 30. pp. 209–213, May, 1913.)—A brief description is given of the direct hydrometric method of computing the amount of evaporation from large lakes, with especial reference to observations carried on in connection with the Zügersee (area 38 km.²) and the Ägersee (area 7 km.²) during 1912. The method consists in making simultaneous measurements of (1) lake level, (2) rate of flow of water from and to the lake, (3) cross-sections of out- and in-flows, (4) rainfall since last observation. The amount of water collected as rain and from inflowing streams is then computed, and the amount carried away by streams, corrected for variation in the level of the lake, will differ from it by the amount of water evaporated. The method is simple in theory but not easy in practice. The results for the year Dec., 1911, to Nov., 1912, give an evaporation of 775 mm. from the Zügersee and 740 mm. from the Ägersee, with maximum in July and minimum in Dec. On account of the rainy character of the season the amount is below the average, which is probably about 900 mm. R. C.

1793. *Observations on Ocean Temperatures in the Vicinity of Icebergs and in other Parts of the Ocean.* **C. W. Waidner, H. C. Dickinson,** and **J. J. Crowe.** (Washington Acad. Sci., Journ. 3. pp. 405–412, Sept., 1913.)—These observations were undertaken, by courtesy of the U.S. Navy Dept., with a view to obtaining information on the possibility of detecting the proximity of ice from temperature-records. Some of the more important apparatus used consisted of the following: (1) A surface electrical resistance thermometer, made up of a flat coil of silk-covered nickel wire enclosed between copper sheets and insulated by thin layers of mica. The resistance of the nickel coil was about 100 ohms. (2) Deep-sea thermometers of the Negretti and Zambra type. (3) Several standard mercurial thermometers. (4) A Leeds and Northrup recorder suitable for use with the resistance thermometers. The surface thermometer was mounted with its flat face directly against the inner surface of the ship's ⅜-in. plates, about 6 ft. below the water-line. Simultaneous measurements of temperature, made with a sensitive mercurial thermometer inserted in the water and with the surface thermometer and recorder, showed that sudden changes in sea-water temperature were indicated by the recorder without any significant time-lag. Practically continuous temperature records were obtained from June 4 to July 10, 1912, and the temperatures ranged from 3° to 25° C. Also variations in the salinity of sea-water in the neighbourhood of icebergs, due to the diluting action of the water resulting from the melting of the ice, were found to be so small as to be entirely masked by the accidental variations found in sea-water. The testimony of numerous observers is on evidence that the echo of the fog-horn may frequently, but by no means always, be detected when in the proximity of an iceberg or even of a bank of fog. The experiment of sounding the fog-horn was tried, but in no instance could an echo be detected, while similar experiments to determine whether an echo occurred under water from the larger, submerged portion of the berg were very inconclusive. Other experiments were tried, such as firing 3- and 5-in. shells into the berg, the utility of searchlights in locating bergs at night, etc., but the results were most disappointing. Samples of ice broken from the berg by gun-fire were found to contain considerable amounts of included air, which probably accounts for the white appearance. The water resulting from the melting of the iceberg was found to have the same density as that of distilled water, being also free from any characteristic taste. So far as the observations went, the temperature of the air furnished no evidence of value as to the proximity of a berg. From a study of the temperature records, the difficulty of separating the large and sudden variations of sea-water temperature, so frequently met with, from any variations that may be caused by the proximity of icebergs proved insuperable. It follows, therefore, that it is practically impossible to draw definite conclusions as to the proximity of ice from temperature records. Curves are drawn to illustrate the temperatures about icebergs. In general there was a fall in temperature of about 1 deg. in 4 or 5 miles in approaching the various bergs, although positive conclusions as to the absence or proximity of ice cannot be made from the records. The authors state, however, that this is not a condemnation of the use of suitable recorders on ships, as such may give valuable information on the approach to shore and shallow water and the identification of characteristic ocean currents. They also state that if the "characteristic iceberg effect" observed by Barnes, *i.e.* rise of temperature on approaching icebergs [Abstract No. 1019 (1912)], had been present round the bergs observed by them, either of the same or even much less magnitude, the records would have rendered such an effect evident, notwithstanding the irregular variations of temperature usually found to exist. In view of the differences in the character of the two records the authors feel it to be very desirable that further observations be made in different parts of the ocean and under varied conditions before attempting to draw final conclusions.

H. H. Ho.

1794. *Radium in Chromosphere.* **S. A. Mitchell.** (Popular Astronomy, June, 1913. Observatory, No. 463. p. 307, July, 1913.)—The spectrum of the chromosphere obtained in 1901 seemed to show that neon and argon were present, but the evidence was inconclusive. Examinations of the better photographs obtained in 1905 have furnished better measures for comparison with the laboratory wave-lengths of the spectra of radium, neon, argon, krypton, and xenon. No coincidences of sufficient certainty have been found to favour the view that these elements are present in the chromosphere. [See Abstract No. 40 (1913).]

C. P. B.

1795. *Diminution of Solar Mass by Radiation.* **J. Bosler.** (Le Radium, 10. pp. 168–170, May, 1913.)—An attempt is made to calculate the amount of the diminution of the solar mass in consequence of radiation. Taking 2·5 as the solar constant, it is found that the sun would lose a mass equivalent to that of the earth, 6×10^{27} gm., in a period of 30 million years.

C. P. B.

1796. *Harmonic Analysis of Relative Sun-spot Numbers.* **H. Kimura.** (Mathematico-Physical. Soc., Tōkyō, Proc. 7. pp. 71–85, April, 1913. Roy. Astronom. Soc., M.N. 73. pp. 543–548, May, 1913.)—The investigation of the variation of sun-spot numbers was undertaken in connection with the discussion of variations of the earth's pole. It is found that the 11-year period is not so conspicuous as is generally supposed, although it has the largest amplitude ; its length is nearer to 11⅓ years than to 11⅛. Many subsidiary periodicities lie between 8 and 12 years. Of the long periods, besides Wolf's 81-year cycle, a definite period of 54 years is detected. C. P. B.

1797. *Theory of Gaseous Solar Photosphere.* **Gouy.** (Comptes Rendus, 156. pp. 852–855, March 17, 1913.)—Working on the hypothesis of a gaseous photosphere, several of the principal actual phenomena are compared with those developed by the application of the theory, on the assumption that the radiation is entirely thermal, and that it obeys Kirchhoff's law. C. P. B.

1798. *Temperature of Moon.* **F. W. Very.** (Science, 37. pp. 949–957, June 20, 1913.)—The author refers to a joint memoir by Langley and himself, published in 1889, wherein the surface temperature of the moon is given as + 45° C. Langley was apparently unwilling to accept unreservedly such a high value compared with the older estimates ; a discussion of the conditions under which the comparisons were made tends rather to make the estimate of lunar temperature go still higher, the later measures assigning a temperature of about 454° C. (abs.) to the lunar subsolar point. C. P. B.

1799. *Evidence for Lunar Atmosphere.* **M. E. J. Gheury.** (Observatory, No. 462. pp. 268–269, June, 1913.)—Observing the occultation of π Scorpii (mag. 3·1) on April 22, 1913, with a 3¼-in. Wray refractor at Eltham, a faint star was seen before the appearance of the much brighter star identified as the one expected. As π Scorpii is not a close double, the appearance is attributed to refraction by the lunar atmosphere. C. P. B.

1800. *Neptune's Faint Equatorial Belts.* **T. J. J. See.** (Astronom. Nachr. No. 4656. Nature, 91. p. 407, June 19, 1913. Abstract.)—The paper gives a summary of some old observations made with the 26-in. refractor at the U.S. Naval Observatory at Washington in 1899–1900. Beaded bands or belts were faintly visible against the brighter body of the planet. C. P. B.

1801. *Origin of Planets and Satellites.* **K. Birkeland.** (Archives des Sciences, 35. pp. 529–564, June, 1913.)—An amplified version of the paper dealt with in Abstract No. 368 (1913), with the addition of several photographs of the discharges obtained. L. H. W.

1802. *Spectrum of Comet Schaumasse* (1913a). **J. Bosler.** (Comptes Rendus, 156. pp. 1653–1654, June 2, 1913.)—Successful photographs of the spectrum of Comet Schaumasse (1913a) were obtained during May, 1913, with exposures varying from 1h. 50m. to 3h. 20m. Three bands are visible on the plates, near wave-lengths 388, 404, 473. C. P. B.

1803. *Photometric Observations of Zodiacal Light.* **Fessenkoff.** (Comptes Rendus, 157. pp. 196–198, July 21, 1913.)—Observations of the zodiacal light have been made with an astrophotometer, during Feb. and March, 1913, at Meudon, and during April and May at Nice. The instrument was kept at the same altitude to avoid errors due to variable atmospheric absorption. The results are tabulated showing the position of the axis of the zodiacal light with respect to the angular distance of the sun along ecliptic. C. P. B.

1804. *Solar Eclipse Expedition to Vavau, Tonga Islands, April* 29, 1911. **W. J. S. Lockyer.** (Solar Physics Committee Report. [82 pp.] London, 1912.)

LIGHT.

1805. *Spectrophotometer for Ultra-violet.* **F. P. Defregger.** (Ann. d. Physik, 41. 5. pp. 1012–1055, Aug. 5, 1913.)—A paper dealing with a spectrophotometer for ultra-violet light, originally designed by H. T. Simon [Ann. d. Physik, 59. p. 61, 1896]. A series of tests showed various defects, which have been in part remedied by modifications of construction. A method is described of securing uniform illumination of the slit for the lens combinations employed. A description is also given of an improved comparator for evaluating the photographic records, which possesses high sensitiveness and is independent of the uniformity of movement of the plate. Possible errors are discussed at length, and experimental tests are described. Proposals are made for an improved construction of the apparatus. A. W.

1806. *Method of Testing Optical Reflectors.* **J. Rey.** (Comptes Rendus, 157. pp. 329–331, Aug. 4, 1913.)—The method dealt with is applicable to parabolic reflectors, and can easily be extended to reflectors of hyperbolic or elliptical form. The reflector under test is mounted on an optical bank, its axis being parallel to the length of the bank. At a little distance from the reflector is placed a vertical frame carrying a rectangular grid with square meshes, made by two sets of wires tightly stretched. A metre behind the frame is placed vertically a ground-glass screen. Using a very small arc as the source of light on the axis of the reflector, a shadow image of the square meshes may be obtained on the screen, being due to the light reflected from the parabolic mirror. If the surface is exactly parabolic, the shadow image of the grid is the same as the grid itself, and consists of straight lines perpendicular to one another. If the shadow image shows curved lines, the surface of the reflector is not parabolic; it is easy to see what parts of the surface have incorrect curvature, and measurements of the error of position of points of the shadow image serve to determine the amount of error in the corresponding part of the reflector. A. W.

1807. *Apparatus for Investigating the Double Refraction of Optical Glass.* **H. Schulz.** (Zeitschr. Instrumentenk. 33. pp. 205–209, July, and pp. 247–253, Aug., 1913.)—Gives further details of the instrument previously described [Abstract No. 888 (1913)], with photographs and diagrams relating to various samples of glass that have been tested with the apparatus. Most of the glasses dealt with show negative double refraction under pressure, but a specimen of flint glass showed positive double refraction. This is of interest, since up to the present positive double refraction under pressure has only been observed with fluorspar and sylvin for certain pressure-directions. A. W.

1808. *Abbe Focometer.* **H. Fassbender.** (Zeitschr. Instrumentenk. 33. pp. 210–218, July, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—A paper describing a method of determining, by means of the Abbe focometer, in what way the positions of the principal planes of a lens system depend on the zone of the lens employed and on the wave-length of the light. [See also Abstract No. 2861 (1904).] A. W.

1809. *Index of Refraction of Liquid Hydrogen.* **W. Meissner.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 540–554, July 15, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—A description is first given, with diagram and photographs, of the plant used for the liquefaction of hydrogen. A total reflection method, using a pair of parallel plates with a gas film between, was employed for determining the index of refraction of the liquid hydrogen. Applying Cuthbertson's measurements to Planck's dispersion formula, the refractive indices for several wave-lengths are calculated, and, as is seen from the following table, agree well with the observed results.

λ	I. ν (obs.).	II. ν (calc.).	I.−II.
0·656 μ	1·1119	1·1102	0·0017
0·589 μ	1·1117	1·1107	0·0010
0·492 μ	1·1122	1·1118	−0·0004

A. W.

1810. *Diffraction Phenomena: Superposed Fringes.* **C. F. Brush.** (Amer. Philosoph. Soc., Proc. 52. pp. 276–282, April, 1913. Paper read before the Amer. Assoc. for Advancement of Science, Dec., 1912.)—The author has found that when diffraction fringes are observed within a mm. or two of the diffracting edge, by means of a microscope, they are very greatly influenced in brightness and sharpness by the contour of the edge. Cylindrical edges were used in most of the experiments, ranging from fine wires of 0·02 mm. diam. up to large brass rods and tubes, always with a smooth surface. The fine wires and needles were screened on one side to confine diffraction to the other side only. The fringes projected by the edge of a sharp razor-blade are weak, few in number and hazy in outline. With a fine wire the fringes are distinctly better. Every time the radius of the cylindrical edge is doubled, the fringes are unmistakably brighter and sharper. Various considerations tend to the conclusion that the very greatly enhanced brightness of the fringes produced by the diffracting edge of large radius as compared with the razor-edge, is due to the superposition of a number of diffraction image patterns which are almost, but not quite, in register. With two razor-blades clamped together with their edges as close as possible (about 0·2 mm.), and as nearly as possible in the same plane, the brightness of the one-blade fringes is approximately doubled, if the combination is rotated slightly about the line of one of the edges, so that the edge nearer the slit may be withdrawn very slightly below the plane of the incident beam which strikes the other edge. It appears that twice as many elements of each wave-front are affected. We may regard the cylindrical diffracting surfaces as consisting of a great many parallel elements, each acting as a diffracting edge and producing its own fringe pattern which is superposed on those of the other elements. Using a glass plate with polished surface 12 mm. wide, Lloyd's so-called "single-mirror interference fringes" were brilliantly shown, the spacing being sensibly uniform and the fringes showing more and more colour from the third onwards. Experiments with an arrangement of 24 paper-thin razor-blades clamped together with the edges all in one plane showed that all the effects obtained with the mirror could be reproduced, differing only, and but little, in brilliancy. Hence it appears that the so-called "single-mirror interference fringes" are not due to interference of light reflected at grazing incidence with contiguous rays not reflected, as commonly supposed, but are superposed diffraction fringes. A. W.

1811. *Fermat's Law.* **D. N. Mallik.** (Phil. Mag. 26. pp. 144–158, July, 1913. From Bull. of the Indian Assoc. for the Cultivation of Science.)—By critically examining Fermat's law of swiftest propagation of light $\delta\int dt = 0$, (where t is the time of propagation and δ is the operator of the calculus of variation) the author concludes that all optical energy is *entirely kinetic.* Hence he is led to infer that *all energy is kinetic.* The view is thus reached, through this optical law, that some subtle ethereal motion is associated with every given configuration of a conservative system existing in a field.

The bearing of this on other modern views is discussed. E. H. B.

1812. *Interference Bands with Partially Silvered Plates, and Absorption Spectra in the near Infra-red.* **A. H. Pfund.** (Zeitschr. wiss. Phot. 12. pp. 341–356, Aug., 1913.)—From the research described it appears that interference bands produced by partially silvered plates can be utilised for dispersion measurements in the infra-red. Interference bands produced in the manner described are very sharp and have great intensity. The absorption spectra of several aniline dyes were obtained in the region 0·55 μ, to 1·2 μ; and some excellent colour-filters for photography in the red and near infra-red were discovered. Colour glasses were investigated in a similar manner, and their inferiority as colour-filters demonstrated. The wave-lengths of the narrow absorption bands of neodymium nitrate and erbium chloride were also measured. The heads of the principal bands in the long-wave region lie approximately at 0·580 μ, 0·780 μ, 0·785 μ and 0·868 μ for the former substance, and at 0·649 μ, 0·687 μ, 0·797 μ and 0·980 μ for the latter. A. W.

1813. *Total Radiation of Hefner Lamp.* **W. Gerlach.** (Phys. Zeitschr. 14. pp. 577–581, July 1, 1913.)—In order to provide a standard of total radiation, the author measured that of a Hefner lamp screened off by a diaphragm placed at 10 cm. from the flame and having a rectangular aperture 14 × 50 mm. Two different lamps and three makes of amylacetate were used. All showed the same value of the radiation, so long as the amylacetate was pure. The error of reproduction should not exceed 1·5 per cent. The value obtained by means of a thermopile is the same as that obtained by Ångström by means of a pyrheliometer. It amounts to $2·25 \times 10^{-6}$ cal./cm.^{2}/sec. at 1 m. This corresponds to a radiation constant of $5·90 \times 10^{-12}$ watts/cm.^{2}/deg.^{4}/sec.

E. E. F.

1814. *Flicker Photometer and the Iris.* **H. C. Stevens.** (Phil. Mag. 26. pp. 180–183, July, 1913.)—Rayleigh [Abstract No. 893 (1913)] has suggested that the flicker sensation might be due to the iris diaphragm in the eye attempting to follow the changing illumination. The author has carried out experiments on two observers whose eyes had been treated with atropine so as to paralyse the muscle controlling the iris. In these circumstances the appearance of the flicker was not changed in any respect from what it was before the atropine was placed in the eyes, the intensity and frequency remaining the same. Some other explanation of the sensation of flicker must therefore be sought. J. S. D.

1815. *On Magneto-optical Rotativity.* **G. H. Livens.** (Phil. Mag. 26. pp. 362–366, Aug., 1913.)—The author's modification of Drude's analysis of the electromagnetic theory of optics is here applied to the question of the additivity of the rotations of liquid mixtures. It would appear that a strict superposition of the rotations of solvent and solute can never take place.

L. H. W.

1816. *Flame Spectra of the Halogen Salts.* **E. N. da C. Andrade.** (Phys. Soc., Proc. 25. pp. 230–233; Discussion, p. 234, June, 1913.)—Wires of certain metals, if held in a chlorinated flame, give characteristic colourations in different zones of the flame. These are due to the chlorides of the metal. The chloride spectra of nickel, cobalt, and iron, also several bromide and iodide spectra have been examined. In the case of those metals, whose colouration of the flame is destroyed by chlorine, the vapours are not charged, while in the case of metallic chlorides which give characteristic spectra, the vapours are strongly charged. J. M.

1817. *Electric-furnace Spectrum of Iron.* **A. S. King.** (Astrophys. Journ. 37. pp. 239–281, May, 1913. Contribution from Mt. Wilson Solar Observatory, No. 66.)—Details are given of a long investigation of the variations with temperature of the electric-furnace spectrum of iron. This type appears to come between the flame and arc spectra. The experiments have been made with a carbon-tube resistance furnace, with which any desired steps of temperature can be measured, up to a point where the vaporisation of the carbon becomes excessive. Current varying from 800 to 1600 amps. was used at pressures from 15–30 volts given by a 50-kw. transformer. The observations of temperature were made with a Wanner pyrometer regularly during the operations. In a series of tables the relative intensities of iron lines in the visible spectrum are given for three furnace temperatures and for the arc, with a division into six classes based on the temperature at which a line appears in the furnace and its rate of growth with increase of temperature. The changes in relative intensities of lines observed in passing from the furnace spectrum to that of the arc may in general be accounted for by a difference in conditions equivalent to a large temperature-difference, though one class of furnace lines presents difficulties. The red end of the iron spectrum appears to require high temperature for its production as compared to the blue region, and the distribution of lines through the visible spectrum bears little resemblance to the intensity gradation observed for the spectrum of an incandescent solid. The ultra-violet region is very rich in lines given by the furnace. The extension of the line spectrum towards shorter wavelength with increase of temperature was observed, it being found that lower limits were reached for a given temperature by the spectrum of an incandescent solid. A list is given of pairs of lines whose members belong to different classes as regards response to temperature changes, and may be used in estimating the relative temperatures of light sources. The enhanced lines of iron in the visible region have not been observed in the furnace spectrum. [See also Abstract No. 1524 (1912).] C. P. B.

1818. *Absorption of Ultra-violet Rays.* **V. Henri.** (Phys. Zeitschr. 14. pp. 515–516, June 15, 1913.)—Describes a new quantitative method for determining the absorption due to a solute. The spectrum is photographed as transmitted by the solvent alone, say for t secs. Then it is photographed through the solution for various exposures t_1, t_2, etc. Finally, those lines are found which give the same blackening in contiguous spectra. The intensities of light of a particular wave-length transmitted through the solvent (I) and the solution (I_1) respectively are given by $I/I_1 = (t_1/t)^n$, where n is a constant depending upon the make of plates. The author gives a series of 45 spectra of acetone solution alternating with water as a solvent. He also states that a strong continuous ultra-violet spectrum may be obtained by a Tesla discharge through water. The spark can be made 5 mm. long. E. E. F.

1819. *Absorption of Ultra-violet Rays by Acetone.* **J. Bielecki** and **V. Henri.** (Phys. Zeitschr. 14. pp. 516–521, June 15, 1913.)—Acetone has a single absorption band in the ultra-violet. Its maximum in an alcoholic solution lies at $\lambda = 2706$, and in aqueous solution 2648. The Ketteler-Helmholtz formula, assuming one sort of electrons, gives a good rendering of the absorption curve over 500 Å.U. There is one electron for 86 molecules. Assuming that in organic molecules the frequencies of the electrons are variable and are distributed according to Gauss's law, the absorption can be represented by an exponential formula which fits most of the results, and which can be retained as an empirical formula even if the assumption should turn out to be incorrect. E. E. F.

1820. *Band Spectra of Mercury.* **J. Stark** and **G. Wendt.** (Phys. Zeitschr. 14. pp. 562–566, July 1, 1913.)—Mercury has at least two distinct band spectra. The first spectrum is obtained with pressures of Hg vapour amounting to 1 to 10 mm., and is radiated by the positive column, with current densities below 1 amp. per cm.^{2}. It has maxima of intensity at 490 to 400 $\mu\mu$, 350 to 310, 270 to 250, at 248, and at 234 $\mu\mu$. The second band spectrum is obtained when a greater power is consumed in the tube. It is identical with that previously studied by Eder and Valenta. There are indications of a third band spectrum emitted by the negative glow, but wanting in the positive column, and consisting each of a series of sharp lines. The authors incline to associate the first band spectrum with the formation of neutral ions each consisting of an electron and a monovalent Hg atom. The second band spectrum probably concerns bi- or tri-valent Hg atoms. E. E. F.

1821. *Mercury Lines and Bands.* **J. Stark** and **G. Wendt.** (Phys. Zeitschr. 14. pp. 567–568, July 1, 1913.)—This is a special study of the mercury lines 2536·7 and 2345·5, and their separation from the bands at 2540 and 2346. The first line is important as being the head of a series attributable to a neutral atom. It is shown, both by emission and absorption spectrograms, that there is no connection between the lines and the adjoining bands. E. E. F.

1822. *Energy Distribution of the Long-wave Radiation of Mercury Vapour.* **H. Rubens** and **O. v. Baeyer.** (Preuss. Akad. Wiss. Berlin, Ber. 38. pp. 802–809, 1913.)—In a previous paper [see Abstract No. 1447 (1913)] it was shown that the twofold division of the Reststrahlen by rock-salt, sylvin, and potassium bromide is brought about by the selective absorption of the water-vapour present in the air of the room in which the experiments were performed; also it was found that the presence of water-vapour in the path traversed by the rays modified considerably, in the spectral region employed, the long-wave radiation of the Auer burner isolated by a special arrangement of quartz lenses. In the present paper the influence of the selective absorption of water-vapour on the energy distribution of the long-wave radiation from mercury-vapour is dealt with. The mercury lamp used was of the same type as used in earlier work [Abstract No. 1678 (1911)]. The research shows that, so far as the water-vapour present in the air in the path of the rays is concerned, it has no appreciable effect on the energy distribution of the long-wave radiation; but if a sufficient amount of water-vapour is introduced into the apparatus, a marked variation of the energy distribution is produced. It also was found that water-vapour absorbs the short-wave part of the radiation much more strongly than the long-wave radiation. A. W.

1823. *Spectra Developed by the Tetrachlorides of Silicon and Titanium.* **W. Jevons.** (Roy. Soc., Proc. Ser. A. 89. pp. 187–193, Aug. 27, 1913.)—In previous papers Strutt and Fowler have given accounts of the spectrum of the afterglow of nitrogen, and of the spectra of various elements and compounds excited by the active modification of nitrogen [Abstract No. 677 (1912)]. The present paper gives an account of the spectra developed on the introduction of the vapours of $SiCl_4$ and $TiCl_4$ into the nitrogen afterglow. The $SiCl_4$ afterglow is notable for the occurrence of a new system of bands between λ3800 and λ4950, with heads degraded towards the red. The bands show intensity minima near the heads, corresponding to the modifications of the cyanogen afterglow bands. The wave-lengths of the heads have been determined, and their frequencies arranged into groups, similar to the classification of the cyanogen bands and the positive bands of nitrogen. The new bands do not occur in the discharge through $SiCl_4$ (which is characterised by a different system of bands) and are therefore attributed to a nitride of silicon. Chemical evidence in support of this has been obtained by Strutt. The $TiCl_4$ afterglow, however, develops no bands of a corresponding nitrogen compound of Ti. Its spectrum is merely that of the titanium arc, together with the group of flutings characteristic of $TiCl_4$. A. W.

1824. *Infra-red Absorption Spectra of Gases.* **W. Burmeister.** (Deutsch. Phys. Gesell., Verh. 15. 14. pp. 589–612, July 30, 1913. Extract from Dissertation, Berlin.)—The light from a Nernst burner was passed through a Wadsworth mirror spectrometer and received finally on a microradiometer. The absorption tube could be introduced in the path of the light or removed at will and again fixed in exactly the same position by means of a pivoted arm to which it was rigidly secured. Various prisms, of fluorspar, rock-salt, and sylvin, permitted different ranges of wave-lengths to be dealt with, and the investigation of the absorption spectra was made in steps of 0·1 μ from 1 μ to 13 μ and of 0·3 μ from 13 μ onwards. The maxima of the absorption bands investigated lie at the wave-lengths shown in the following table, double bands being given in brackets and wave-lengths in μ :—

Cl_2	—	H_2	—
Br_2	—	O_2	—
HCl	[3·40 ; 3·55]	HBr	[3·84 ; 4·01]
$(CN)_2$	[3·79 ; 3·93] ; 4·65 ; 13·50 ; 16·07		
HCN	3·04 ; [6·95 ; 7·22] ; [13·60 ; 14·33]		
C_2H_2	2·52 ; 3·07 ; 3·77 ; [7·39 ; 7·66] ; [13·50 ; 13·95]		
CO	2·35 ; [4·60 ; 4·72]	CO_2	[14·70 ; 15·05]

No researches up to the present have revealed any gaseous element having a measurable absorption band below 1 μ. It is remarkable how many absorption bands are found to be double on sufficient investigation. HCl and HBr have both only one double band, that of HBr being distorted considerably on the side of the longer waves. CO_2 and CO show similar absorption only at 5 μ. There is no analogue in the CO spectrum to the third CO_2 band. There is a marked similarity shown in the absorption spectra of such different gases as HCN and C_2H_2. On the other hand $(CN)_2$ and HCN have no similar bands, although they possess the same ion (CN). [See also Abstracts No. 1562 and 1868 (1909).] A. W.

1825. *Measurement of Zeeman-effect.* **G. F. C. Searle.** (Astrophys. Journ. 37. pp. 282–287, May, 1913.)—Purvis has drawn attention to the discrepancies between the values of the Zeeman-effect obtained by him in the case of certain lines in the spectrum of chromium, and the values obtained by Miller, Hartmann, and Babcock. [Abstract No. 148 (1912).] Purvis used a field of 39,980 c.g.s. Further discussion was provided by Cotton [Abstract No. 1193 (1912)]. Searle now states that he made the experiments giving the field strengths quoted by Purvis, and describes the precautions taken to avoid errors in the determinations. Since the first tests, however, defects due to overheating, etc., appear to have developed in the coil windings of the magnet, and a recent re-determination of the field given by 20 amps. gives the value 28,700 c.g.s., whereas in the measurements in 1903 the same exciting current gave a field of 39,700 c.g.s. Details are given of the constants of the exploring coil used in the new experiments. C. P. B.

1826. *Anomalous Zeeman-effect of Spectral Lines of the* D-*type.* **W. Voigt.** (Ann. d. Physik, 42. 1. pp. 210–230, Aug. 26, 1913.)—A continuation of previous work [Abstract No. 1441 (1913)] in which further treatment is given of the author's coupling theory of the Zeeman-effect observed with line systems of the D-type. A. W.

1827. *Phosphorescence of Mercury-vapour after Removal of the Exciting Light.* **F. S. Phillips.** (Roy. Soc., Proc. Ser. A. 89. pp. 39–44, Aug. 1, 1913.)—Wood has shown that light of wave-length 2536 produces resonant radiation in mercury-vapour even when the vapour has only the very small density corresponding to ordinary temperatures [Abstract No. 1182 (1912)]. Under these circumstances the exciting radiation could penetrate a distance of a few cm. into the vapour without total absorption taking place, but if the temperature was higher and the vapour consequently denser the radiation could only penetrate a few mm. Wood does not appear to have stated that this 2536 light produces visible fluorescence in mercury-vapour. This, however, is the case, and it is excited at a much lower pressure than when cadmium light is used. Experiments showed that there are apparently three distinct phenomena excited by 2536 light in mercury-vapour: (1) Resonant radiation, which exists over a long range of pressure from about 0·001 mm. to about 1 cm. (2) Ordinary fluorescence, which does not rapidly grow less bright as the beam passes through the vapour: this exists when the pressure of the mercury-vapour is about 1 cm. (3) Local fluorescence at the point of entrance of the beam: this exists at much lower pressures than the ordinary fluorescence, but not at the very low pressure corresponding to ordinary temperature. It is this local fluorescence that has been found to be persistent. A beam of the exciting light was passed across a moving column of vapour, obtained by distilling mercury in a long evacuated tube in the form of an inverted U. The exciting light of wave-length 2536 was obtained by means of a water-cooled silica lamp. When the light was passed across the moving column of vapour the fluorescence was carried along with the vapour for a distance of some 18 in. from the point of excitation. There appears to be some connection between the resonant radiation and the persistent fluorescence. Certain observations seem to show that about 1/20 of the secondary radiation in Wood's experiment was probably due to moving molecules. The rest would be produced by scattered light from the primary beam. Besides mercury, the vapours of such substances as iodine, anthracene, and retene were experimented with in order to ascertain whether the fluorescence of the vapours persisted, but no positive results were obtained. A. W.

1828. *Production of Röntgen Rays by Slowly-moving Electrons.* **H. Dember.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 560–565, July 15, 1913.)—Electrons are produced by ultra-violet light from a potassium electrode in a vacuum tube. They are subjected to a weak electric field, and under the influence of this field they move towards an antikathode of Pt, where they generate Röntgen rays by their impact. The Röntgen rays are detected by allowing them to fall on a Pt. plate connected to an electrometer. This plate is protected by a metal cylinder which is kept at a somewhat higher potential than the antikathode, the whole arrangement being so designed as to prevent electrons from reaching the Pt plate in the cylinder. It is found that Röntgen rays are not produced when the electric field in which the electrons move is less than 18·7 volts. The wave-length of the Röntgen rays produced with this field is calculated to be 74·5 $\mu\mu$, which is near that of extreme ultra-violet radiation. It is pointed out that the corresponding frequency is very nearly the frequency of free vibration of the atom of gases [see Abstract No. 362 (1910)], and that therefore the cessation of production of Röntgen rays with an applied field of 18 volts may be due to absorption of the radiation in the gas film on the antikathode. [See also Abstract No. 1332 (1911).] T. P. B.

1829. *Passage of X-rays through Metals.* **E. Hupka.** (Phys. Zeitschr. 14. p. 623, July 15, 1913.)—When X-rays are transmitted through Pt-foil of 0·01 mm. thickness, the impression on a photographic plate is not a simple patch with hazy outline, but a patch surrounded by radial stripes, which become irregular points on annealing the metal. Gold shows the same effect somewhat feebler, but not iron or Al. The author attributes this effect to microcrystals in the Pt and Au. Some of the photographs are reproduced. E. E. F.

1830. *Reflection of X-rays by Crystals.* **W. H. Bragg** and **W. L. Bragg.** (Roy. Soc., Proc. Ser. A. 88. pp. 428–438, July 1, 1913.)—In the discussion of the Laue photographs it has been shown that they may conveniently be interpreted as due to the reflection of X-rays in such planes within the crystal as are rich in atoms [Abstract No. 604 (1913), etc.]. This leads at once to the attempt to use cleavage planes as mirrors, and it has been found that mica gives from its cleavage plane a reflected pencil strong enough to make a visible impression on a photographic plate in a few minutes' exposure. The present paper deals with the reflection of a beam of X-rays by the cleavage faces of various crystals, an ionisation method, using SO_2, being employed to measure the strength of the reflected rays. The apparatus corresponds to a spectrometer, the parallel planes in which the atoms of the crystal are arranged taking the place of the lines of a grating, and the ionisation chamber that of the telescope. A fine slit in front of the X-ray bulb allows a beam of rays to fall on the face of the crystal, and both crystal and ionisation chamber turn about the axis of the instrument and can be set at any desired angles. By this method the authors have found evidence of the existence of three very homogeneous components in the rays from the bulb employed which are only reflected from the crystal at definite angles. They show as a very strong reflection "peaks" superimposed on the general reflection which takes place at all angles. Each of these has a definite absorption coefficient in Al, and can be recognised when reflected from many crystals. One of the sets of homogeneous rays appears to correspond to that found by Chapman for the characteristic radiation of Pt (the antikathode was Pt). Thus rays of definite quality are reflected from a crystal when, and only when, the crystal is set at the right angle, this angle θ being given by $n\lambda = 2d \sin \theta$, in which λ is the wave-length of the rays used, d the distance apart of the planes of atoms in the crystal, and n is any small integer. The wave-length of one of the sets of rays is thus estimated to be $0{\cdot}89 \times 10^{-8}$ cm. Since the reflection angle of each set of rays is, as the experiments show, sharply defined, the waves must occur in trains of great length. A succession of irregularly spaced pulses could not give the observed effect. In the application of electromagnetic theory to monochromatic light on the one hand, and to homogeneous X-rays on the other, there is no difference to be considered beyond that of wave-length. The authors consider, however, that the results do not affect the use of the corpuscular or "entity" theory of X-rays. E. M.

1831. *Spectrum of Röntgen Rays.* **J. Herweg.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 555–556, July 15, 1913.)—Using a soft X-ray bulb and a gypsum plate, the author has obtained photographically an X-ray spectrum similar to that obtained by W. H. and W. L. Bragg [see preceding Abstract]. The experiments were made with angles of 8° to 12° with the face of the crystal. With suitable dispositions the photographs showed three sharp dark lines on a continuous background. To avoid any "blurring" of the image due to a shift of the point of impact of the kathode rays the X-ray bulb was rotated so that the X-rays used consisted of a pencil almost glancing along the plane of the antikathode. E. M.

1832. *X-rays and Crystals.* **W. H. Bragg.** (Nature, 91. p. 477, July 10, 1913.)—In continuation of previous work [see Abstract No. 1330 (1913)] the author finds that an X-ray bulb having a rhodium antikathode gives off a strong, sharply defined (and therefore very homogeneous) beam which is reflected from the (1.0.0) face of rock-salt at a glancing angle of 6·2°. Its mass absorption coefficient in Al is 8·2. A second, weaker beam is reflected at an angle of 5·8°, and this appears to complete the rhodium X-spectrum. The wave-lengths of these beams are calculated to be $0{\cdot}61 \times 10^{-8}$ and $0{\cdot}57 \times 10^{-8}$ cm. respectively. The various experiments show that Pt and Rh give much stronger homogeneous reflected rays than Ir, W, or Ni. E. M.

1833. *Reflection of X-rays.* **H. G. J. Moseley** and **C. G. Darwin.** (Phil. Mag. 26. pp. 210–232, July, 1913.)—X-rays "reflected" from crystals have the general properties of ordinary X-rays. The radiation from an X-ray tube with a Pt target is of two kinds: (A) radiation of indefinite wave-length, analogous to white light; (B) five types of monochromatic radiation, probably characteristic of the Pt. The radiation (A) is reflected at all angles of incidence, but the reflection coefficient is small, certainly not greater than 0·005 for mica at the most favourable incidence, and rather less than that for selenite and potassium ferrocyanide, for which the most favourable incidence is $1\frac{1}{2}$° and $1\frac{3}{4}$° respectively. Each of the radiations (B) is reflected only at special angles, consistent with the simple theory of interference. The wave-lengths are $1{\cdot}642$, $1{\cdot}397$, $1{\cdot}375$, $1{\cdot}194$, and $1{\cdot}157 \times K^{\frac{1}{3}} \times 10^{-8}$ cm., where K is probably either 1, $\frac{1}{2}$, or $\frac{1}{8}$. In rock-salt the angles of spiral reflection from the cube face range from 18° 31′ to 9° 29′. The authors have examined the homogeneity of the radiations and attempted to estimate the distribution of energy in the wave-lengths for the general X-rays. E. E. F.

1834. *Form of X-ray Interference Patterns.* **M. Laue** and **F. Tank.** (Ann. d. Physik, 41. 5. pp. 1003–1011, Aug. 5, 1913.)—In the Friedrich and Knipping photographs [Abstract No. 1153 (1913)] the spots corresponding to the max. effects are always elongated, the greatest length being perpendicular to the radius vector from the central image to the spot. This is most marked in the pattern due to zinc sulphide. The authors have found similar effects with various crystals so long as the distance between the crystal and the antikathode is small, but the effect becomes less marked as this distance is increased, until with 150 cm. distance it is not shown at all. The elongated shape of the spots is thus traced to the curvature of the wave surface as it reaches the crystal, and the authors modify the general theory to take this into account. The theory also brings out that the elongated form of pattern will arise whenever the rays traverse the crystal in a direction parallel to a principal crystallographic axis. The authors also discuss the absence of temperature effect on the interference patterns in the light of the assumption that the crystal consists of a large number of independent elements each having about $7{\cdot}5 \times 10^3$ atoms. [See also Bragg, Abstract No. 989 (1913).] E. M.

1835. *X-rays and Crystals.* **W. H. Bragg.** (Engineering, 96. pp. 422–423, Sept. 26, 1913. Paper read before the British Assoc., Birmingham, Sept., 1913.)—[See Abstracts Nos. 1830 and 1832 (1913).]

1836. *Nature of X-rays.* **C. G. Barkla.** (Engineering, 96. p. 422, Sept. 26, 1913. Paper read before the British Assoc. at Birmingham.)—The evidence in favour of the electromagnetic wave theory of X-rays is first reviewed. Passing to characteristic (fluorescent) X-radiation, the author states that it is homogeneous and characteristic of the element which emits it; the intensity varies with that of the primary, inasmuch as the characteristic rays are not excited by softer rays. As measured by the ionising power the intensity of the characteristic rays shows that they do not carry away all the energy used up in their production, so that the total ionising power of the primary and secondary radiations is smaller than the original energy. Turning to corpuscular radiations, the author states that a substance exposed to X-rays emits electrons whose velocity depends on the penetrating power of the primary radiation, short waves giving high velocities, the energy being proportional to the frequency. The corpuscles carry all the ionising power, but not all the energy. The preponderating distribution is at right angles to the direction of propagation, but more corpuscles are hurled out on the emergent side than on the incident side, as in the case of ultra-violet light. Whatever the intensity of the radiation of a given type, corpuscles are ejected by it with the same velocity. This seems inexplicable at present. E. M.

1837. *Decrease in Velocity of α-Particles in Passing through Matter.* **E. Marsden** and **T. S. Taylor.** (Roy. Soc., Proc. Ser. A. 88. pp. 443–454, July 1, 1913.)—It is becoming recognised that one of the most fruitful sources of information as to the internal structure of atoms is provided by the phenomena attending the passage of swift electrified particles through them [Abstract No. 1847 (1911)]. Darwen [Abstract No. 1706 (1912)] and Bohr attempted to obtain information as to the number and distribution of electrons in the atom by a consideration of the absorption or loss of velocity of the α-particles in passing through matter. The only data for this purpose so far obtainable are provided by the relations between velocity and thickness of matter traversed, in Al as determined by Rutherford, and in mica as determined by Geiger. A more complete investigation of these velocity curves in various substances is therefore of interest, more particularly as the earlier observations are subject to slight errors due to the assumption that equal thicknesses of matter have the same air equivalent at different parts of the range of α-particles. In the present experiments the velocity curves in Au, Cu, Al, mica, and air have been determined, using as source the α-particles of RaC. The velocities of the α-particles before and after passing through sheets of matter of various thicknesses are measured by the deflection of the particles in a known magnetic field. The mean value found for *mv/e* from the observed deflections is $4{\cdot}00 \times 10^5$ e.m. units. In no case has it been possible to obtain with certainty a velocity of less than about 0·415 of the initial velocity of expulsion. It is possible that in the beam of α-particles after passing through 6·5 cm. air equivalent the velocities are distributed within the limits 89 to 47 % of the initial velocity. With further absorption the particles of higher velocities may become degraded in velocity. There is a difficulty in accounting for the absence of α-particles of lower velocities. It is possible they no longer produce scintillations. This point is investigated with different zinc sulphide screens, but with negative results. But even if they no longer produce scintillations then it is probable that they also no longer ionise, for the ranges of α-particles determined by the scintillation method are the same as those determined by the ionisation method. The results may possibly be explained by assuming that when the velocity of an α-particle falls below a certain value it is subject to a new special type of scattering, possibly by some kind of subcentral charge present in the atom. An alternate explanation may be obtained on the assumption that at this particular velocity the α-particle takes on an electron and then has only one positive charge. This would account for the limiting velocity coming practically the same in all the substances. An attempt is made to detect such singly-charged α-particles, but only one line of scintillations in the magnetically deflected beam is observed. Geiger apparently obtained one value of the velocity as low as 0·27; but attempts to repeat his conditions met with no success. Whether his result may prove correct or not there must be some very radical change accompanying the absorption of the α-particles when their velocity falls to 0·41 of the initial velocity. There is a discussion of the figures given for the velocity curves in the various materials. A. E. G.

1838. *Passage of β-rays through Matter.* **J. G. v. Jungenfeld.** (Phys. Zeitschr. 14. pp. 507–514, June 15, 1913.)—Determines the ratio (μ/D_0) for various salts and alloys, where μ is the absorption coefficient for β-rays and D the density. The ratio represents the reciprocal of the penetrating power for an infinite thin layer. The results show that the penetrability of a compound decreases when one element is replaced by another of greater atomic weight. Thus, in the haloid salts, the fluoride, chloride, bromide, and iodide have increasing absorbing powers. The position of ammonium chloride between KCl and $BaCl_2$ is explained by the fact that it contains four H-atoms, which, according to Schmidt, possess great absorptive power. [See Abstracts, Nos. 1516 (1907) and 1438 (1910).] E. E. F.

HEAT.

1839. *Thermal Conductivity of Air at Low Pressures.* **A. Trowbridge.** (Phys. Rev. 2. Ser. 2. pp. 58–64, July, 1913.)—Describes the determination of the conductivity of air at pressures of about a thousandth of a mm. of mercury undertaken as a subsidiary to another research still in progress. E. H. B.

1840. *Thermal Expansion of Liquids between Boiling-point and Critical Point.* **J. Meyer.** (Festschrift W. Nernst, pp. 278–301, 1912.)—By plotting the coefficient of expansion, between absolute zero and the critical point, against temperature, a curve is obtained having neither maximum nor minimum in the case of a normal liquid. When change in temperature is accompanied by change in molecular condition, curves are obtained showing maxima or minima or both, nitrogen peroxide, water, and nitrous oxide being examples of these three abnormal types. By means of a special apparatus, the expansion of liquids considerably above their boiling-points has been determined at very low pressures, *e.g.* water up to 200°, benzene up to 168°, ethyl alcohol up to 155°, methyl ethyl ether up to 85°, ethyl ether up to 115°, and isopentane up to 95° C., the results showing that the coefficient of expansion increases very considerably with the temperature, and in the case of the three last named, the expansion coefficient changing in a perfectly continuous manner when the transition from liquid to gas occurs at the critical temperature. With water, benzene, and ethyl alcohol, the observations were not carried to the critical temperature, but similar behaviour appears probable. W. H. Si.

1841. *Capacity for Heat of Metals at Different Temperatures.* **E. H. Griffiths and E. Griffiths.** (Roy. Soc., Phil. Trans. 213. pp. 119–185, July 28, 1913. Roy. Soc., Proc. Ser. A. 88. pp. 549–560, July 18, 1913. Abstract.) —The authors have measured the specific heats of a number of metals at temperatures varying from 0° to 100°. Masses ranging from 1 to 4 kg. were used and were heated through a given temperature, not exceeding 1·4 deg., by electrical means, the temperature changes being measured by differential platinum thermometers. The apparatus was constructed with all the parts duplicated, two similar masses of metal being suspended by quartz tubes in similar air-tight brass cases, which were placed side by side in a large tank containing rapidly stirred water or oil. This tank was electrically controlled with great constancy at any given temperature (θ_0). One of the metal blocks remained at the tank temperature throughout the experiment, while the other, having been previously cooled below θ_0, was heated to a similar extent above θ_0 by heat developed electrically in the centre of the block, the difference in temperature between the two blocks being determined at regular intervals. Any changes in the surrounding conditions would affect both blocks equally, measurement of the difference of temperature thus eliminating many sources of error. The dependency of the specific heat at temperature t lying between 0° and 97·5°, or, with zinc between 0° and 128·4°, is expressed by the following formulæ: Copper, $S_t = 0{\cdot}09088\ (1 + 0{\cdot}0005341t - 0{\cdot}00000048t^2)$; aluminium, $S_t = 0{\cdot}20957\ (1 + 0{\cdot}0009161t - 0{\cdot}0000017t^2)$; iron (ingot), $S_t = 0{\cdot}1045\ (1 + 0{\cdot}001520t - 0{\cdot}00000617t^2)$; zinc, $S_t = 0{\cdot}09176\ (1 + 0{\cdot}0005605t - 0{\cdot}00000178t^2)$; silver, $S_t = 0{\cdot}05560\ (1 + 0{\cdot}0003896t - 0{\cdot}000000141t^2)$; cadmium, $S_t = 0{\cdot}05475$

$(1+0{\cdot}000520t-0{\cdot}000000725t^2)$; tin, $S_t=0{\cdot}05368\ (1+0{\cdot}0006704t-0{\cdot}000000458t^2)$; lead, $S_t=0{\cdot}03020\ (1+0{\cdot}000400t-0{\cdot}00000086t^2)$. If the values of S at 0° are plotted against the atomic weights (A), all the points show close approximation to the curve $S=4{\cdot}804\times A^{-0{\cdot}95}$, except in the case of tin, for which the value of S exceeds the curve value by 4·6 per cent. Application of this relation to other elements for which the values of S are available shows good agreement in a number of cases and fair agreement (8–16 per cent.) in others, whilst in some instances the calculated and experimental values are totally different; among the last are carbon, the calculated value for which (0·458) is almost exactly four times that of the diamond (0·113), and amorphous boron, which gives an experimental value (0·250) very nearly half the calculated number (0·492). The experimental numbers for gases must be doubled to approach the calculated ones. T. H. P.

1842. *Specific Heat of Hydrated Salts.* **L. Rolla** and **L. Accame.** (Accad. Lincei, Atti, 22. pp. 109–116, Aug. 7, 1913.)—The specific heats of sulphates of zinc, magnesium, and iron, containing different quantities of water of crystallisation, have been determined with a Schottky calorimeter, containing toluol [Abstract No. 2086 (1909)], and the molecular heats of the last molecules of water of crystallisation in the first two salts, and of the three last molecules of water in $FeSO_4 . 7H_2O$, calculated. These results agree fairly closely with the values deduced from Nernst's formulæ, so that the law of Garnier-Kopp is approximately verified. The molecular heats of the monohydrated sulphates of zinc and magnesia are 34·78 and 33·21 respectively. It is concluded that the molecular heat of water of crystallisation is, at ordinary temperatures, equal to that of ice. W. H. Si.

1843. *Improved Method for determining Specific Heats of Liquids, with Data concerning certain Dilute Acids and Alkaline Hydroxides.* **T. W. Richards** and **A. W. Rowe.** (Amer. Acad., Proc. 49. pp. 173–199, Aug., 1913.)—An improvement on the apparatus previously used [see Abstract No. 1446 (1908)] is now described in which the alkali to be neutralised by acid in the centre of a calorimetric system in order to supply a definite quantity of heat, is now contained in a small Pt vessel which itself is inside the Pt vessel containing the acid. In this way equality of temperature before neutralisation is ensured. In the original apparatus the alkali was introduced from outside at the moment of neutralisation, which usually necessitated a correction being applied for its different temperature. Details of the preparation and purification of the substances used and of the determination of their specific heats are given. From the molecular heats obtained it is concluded that the thermal capacity of a solution of a strong acid or base containing at least 100 molecules of water per molecule is increased by the addition of water by an amount equal to the thermal capacity of the added water. It is thus possible to calculate the specific heat of any more dilute solution. The molecular heats of equimolecular solutions of the various substances used are also shown to vary in a systematic manner. F. J. H.

1844. *Experimental Proof of T^3 Law for Decrement of Specific Heats of Solids at Low Temperatures.* **A. Eucken** and **F. Schwers.** (Deutsch. Phys. Gesell., Verh. 15. 14. pp. 578–588, July 30, 1913.)—Gives the results of various measurements of the specific heats of lead (from 15·95° to 92·0° abs.), of fluorspar (from 17·5° to 86·0°), and of pyrites (from 21·7° to 84·0°). At low temperatures the molecular heats of fluorspar and pyrites show a decrement proportional to the cube of the absolute temperature, and this region extended from small (about 0·07 cal.) to relatively high values (about 1·0 cal.) of the molecular heat. Within this region the theory of Debye is valid. Over the whole temperature region the molecular heat of fluorspar follows the general function of Debye, whereas at higher temperatures pyrites shows distinct deviations from it. [See Abstract No. 446 (1913).] E. H. B.

1845. *Calculation of Specific Heats from Elasticities.* **A. Eucken.** (Deutsch. Phys. Gesell., Verh. 15. 14. pp. 571–577, July 30, 1913.)—Various recent researches agree in leading to the result that the energy density in solid bodies at low temperatures must satisfy the same relation as for radiation density, viz., the Stefan-Boltzmann law—

$$u = 1{\cdot}0828\,\frac{48\pi h}{c^3}\left(\frac{kT}{h}\right)^4 z\,;$$

in which h is Planck's universal *Wirkungsquantum*, T the absolute temperature, k the gas constant per molecule; c is for a solid body the mean speed of sound, for the ether the speed of light; finally z is a numerical factor which for a solid body has the value 3/2 and for the ether is unity.

Following up this relation, the author concludes that it is at present to be accepted that the theoretically derived relation between elasticity and specific heat for crystals at low temperatures is valid and in agreement with experiment. [See Abstracts Nos 446 and 626 (1913).] E. H. B.

1846. *Determination of Specific Heats at Low Temperatures; Calculation of Electromotive Force.* II. **F. Pollitzer.** (Zeitschr. Elektrochem. 19. pp. 513–518, July 1, 1913.)—The author [see Abstract No. 366 (1911)] had dealt with galvanic cells from the standpoint of Nernst's heat theorem, and had relied on Einstein's formula for the atomic heat. This formula having since been modified by Nernst and Lindemann, he makes new experiments at temperatures from −100° down to the temperature of boiling hydrogen, and recalculates his former results. The new experiments concern Hg, $ZnSO_4 . 7H_2O$, Hg_2SO_4, HgCl, TlCl, and ice; the values found agree with the modified formula. From those specific heats he deduces the electromotive forces of the combination Hg | HgCl | $PbCl_2$ | Pb, and of others containing also Ag and AgCl; they agree with the more recent experimental determinations of the heat of formation of HgCl, AgCl, $PbCl_2$, whilst differing very considerably from Thomsen's figures. The results also confirm the author's previous work which E. Cohen had attacked. H. B.

1847. *Sublimation of Metals at Low Pressures.* **G. W. C. Kaye** and **D. Ewen.** (Roy. Soc., Proc. Ser. A. 89. pp. 58–67, Aug. 1, 1913.)—Numerous observations, a *résumé* of which is given by the authors, have been made which show that metals volatilise at temperatures considerably below their melting-points. Experiments are now described which confirm the work of Reboul and Bollemont [Abstract No. 1768 (1912)] that there is, in addition to ordinary volatilisation, an emission of particles at right angles to the surface of heated metals similar to that obtained from the kathode of a discharge tube. Iridium heated in nitrogen at 20 mm. pressure, copper heated to 800° in nitrogen at 2 mm. pressure, iron heated to 950°, and tungsten to 1800°, both *in vacuo*, were used, and photographs are given of the results with copper and iron. The experiments with iron show the max. range of the particles to be about 1 cm. The deposit gives an iron reaction, but no loss in weight of the specimen detectable by a chemical balance is observed. The surface of the specimen upon examination under a high-power microscope reveals a regularly oriented pitting, and the fact that this is more marked when the specimen is heated by direct current than when heated in a furnace leads the authors to suggest that the particle emission is electrical in origin. Suggestions based on the crystalline structure of the metal are also given. F. J. H.

1848. *Vapour Pressures of Metals.* I. **H. v. Wartenberg.** (Zeitschr. Elektrochem. 19. pp. 482–489, June 15, 1913.)—By the method used for the determination of the vapour pressure of silicon (Zeitschr. anorg. Chem. 79. p. 76, 1912) the author determines the vapour pressures of lead, silver, and thallium in hydrogen and nitrogen atmospheres within the pressure-range 10^{-5} to 10^{-7} atmo., and also the boiling-points and heats of evaporation of these metals. The results are tabulated. Copper and platinum showed, in a nitrogen atmosphere, at 1886° C. vapour pressures below 10^{-5}; but tin evaporated noticeably. H. B.

1849. *Thermal Properties of Carbonic Acid at Low Temperatures.* **C. F. Jenkin** and **D. R. Pye.** (Roy. Soc., Phil. Trans. 213. pp. 67–117, July 28, 1913.)—Details of a continuous-flow method of measuring the various quantities necessary for constructing a $\theta\phi$ diagram for CO_2 between $-50°$ C. and $+20°$ C. are given, together with a comprehensive series of results and a diagram constructed from them. The direct measurements comprise: (*a*) Data for pressure-temperature curve of the saturated vapour; (*b*) Latent heat of vaporisation, total heat of the liquid and specific heat of the gas at various temperatures and pressures; (*c*) Joule-Thomson effect of the liquid; (*d*) Dilatation and elasticity of the liquid. From these are calculated: (*e*) Specific volume of the saturated vapour; (*f*) Specific heat of the liquid at constant pressure. The general procedure consisted in sending liquid CO_2 at temperature θ_1 and pressure p_1, first, through a throttle valve to reduce its temperature and pressure to θ_2 and p_2, then, at constant pressure p_2 through an electrically heated calorimeter to evaporate and superheat, and, finally, through a compression pump and condenser to bring it back to its original state. The temperatures of the CO_2 at various points were measured by means of inserted thermo-couples, the pressures by Bourdon gauges, and the current of CO_2 by steel weighing flasks placed in the liquid portion of the circuit. This general arrangement was suitably modified according to the quantity to be measured. The $\theta\phi$ diagram obtained, which includes liquid and gas limit curves, lines of constant total heat, and lines of constant dryness, is considered to be more accurate than that previously given by Mollier [see Abstract No. 961B (1904)], since it is constructed from the results of direct measurement, whereas that of Mollier is based on a mathematical equation obtained from experiments at higher temperatures. The agreement is, however, remarkable in view of the limited data Mollier had at his disposal and the very different method used in constructing the diagram. F. J. H.

1850. *Radiation Theory.* **D. Hilbert.** (Phys. Zeitschr. 14. pp. 592–595, July 1, 1913. Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 3. pp. 409–416, 1913.)—The author puts down five axioms regarding the monochromatic or total exchange of energy, the velocity of light, and the emission and absorption coefficients, and determines which combination of these axioms leads to Kirchhoff's laws. E. E. F.

SOUND.

1851. *Pianoforte Touch.* **S. Pickering.** (Nature, 91. pp. 555–556, July 31, 1913.)—The question as to whether what is known as touch is due to any peculiarity, apart from the energy, with which the hammer strikes the strings, and, consequently, with which the fingers strike the keys, would appear to be determinable by direct experiment. The author had always held that touch is dependent on such peculiarities, but has found as follows that the evidence is decidedly against this view. A note was struck one hundred times in succession so as to produce sound of as nearly as possible the same intensity; on half these occasions it was struck in a pressing or caressing manner; in the other cases it was struck sharply; the different kinds of blows were intermingled irregularly and according to a list previously drawn up, and the damper was held up while the note was being struck. As each note was struck a verdict as to its quality was given by a person sitting out of view of the piano, and this verdict was compared with the character of the blow given. This observer was not a trained musician, but was exceptionally appreciative of what is called "touch." Discarding all cases where the note had accidentally been more or less loud than the average, it was found that in 49 per cent. of the cases of uniform loudness the effect on the auditor coincided with the character of the blow given, in 51 per cent., the reverse. In another series of 100 notes, the values were 51 and 49 respectively. It is evident, therefore, according to this, that different quality of touch (in the above sense) produces no difference in the quality of the sound produced. Even if the independence of touch on the character of the stroke were fully established, there is no difficulty in explaining the apparent difference in touch of a performance with the fingers and one with a piano-player. At least seven factors may be specified as determining touch:—(1) Differences in loudness of a note or notes compared with that of preceding notes; (2) deviation from the theoretical value of degree of *staccato* or *legato*; (3) variations in time as compared with that of preceding notes; (4, 5, and 6) similar differences in loudness, duration and time of one note in reference to its nominally contemporary notes; (7) use of the loud pedal.

A discussion of the piano-player, its defects and possible improvements follows. E. H. B.

1852. *Dust-figures.* **J. Robinson.** (Phys. Soc., Proc. 25. pp. 256–268; Discussion, p. 268, June, 1913.)—The ripple formation in Kundt's tube was first satisfactorily explained by W. König in 1891. His theory was based on the hydrodynamical forces between two particles in a stream. All the known facts about these figures fall into line with the theory. The distance apart of the ripples increases with the intensity of the sound, and also from the node to the antinode there is a variation of the ripple pitch as required by theory. Certain measurements on dust figures produced by an electric spark have shown that these figures can only be explained in a similar way to the Kundt's tube figures. It was suggested by Cook [Abstract No. 1865 (1902)] that viscosity must be introduced in order to account for the formation of the ripples. The author here shows that it is possible to account for the ripple formation without the introduction of viscous forces at all. Indeed these act rather as a disturbance than a help. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1853. *Collisions of Slow Electrons and Gas Molecules.* II. **J. Franck** and **G. Hertz.** (Deutsch. Phys. Gesell., Verh. 15. 14. pp. 613–620, July 30, 1913.)—What was made highly probable in the first part of this work is now established, viz. that the collisions of electrons and gas molecules are the more elastic the less the affinity between the electrons and the molecules in question. For helium, hydrogen, and oxygen it is shown that the electrons needing energy for ionisation do not attain their proper free path. In helium the ionisation energy may be won by very many collisions, in hydrogen this number is curtailed, and in oxygen it is yet smaller, since the strong electronegativity of the oxygen causes distinctly unelastic collisions between electrons and its molecules. [See Abstract No. 1819 (1913).] E. H. B.

1854. *Plane Dispersion.* **C. Schaefer** and **H[elene] Stallwitz.** (Preuss. Akad. Wiss. Berlin, Ber. 36. pp. 674–685, 1913.)—Mathematical treatment of the plane diffraction of electromagnetic waves by gratings. [See Abstracts Nos. 1276 (1905) and 134 (1906).] E. H. B.

1855. *Observations of Atmospheric Electricity at Seeham, near Salzburg, in the Summer of* 1912. **E. v. Schweidler.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 137–152, Jan., 1913.)—Conductivity of the air, potential gradient, and air-earth current were observed in the summer and autumn of 1912, and the following mean values were obtained for a position 500 m. distant from the shore of Lake Obertrümer :—Total conductivity $= 2{\cdot}78 \times 10^{-4}$ e.s. unit ; $q = \lambda_{+}/\lambda_{-} = 1{\cdot}02$; potential gradient = 95 volts/m. ; air-earth current $= 8{\cdot}2 \times 10^{-7}$ e.s. unit per cm.^{2}. The diurnal range of potential gradient is small so that that of the air-earth current conforms with that of conductivity. At a second place of observation above the water near the shore the conductivity is markedly diminished, q is greater than unity, and the daily range of conductivity is considerably different from that at the former place of observation. [See Abstract No. 474 (1912).] R. C.

1856. *Observations of Atmospheric Electricity in Argentina.* **G. Berndt.** (Meteorolog. Zeitschr. 30. pp. 363–366, July, 1913. Paper read before the Deutsch. Wiss. Verein, Buenos Aires.)—Regular observations of atmospheric electricity on the continents of the Southern Hemisphere are very scanty. Beyond some observations of Neumayer in Melbourne, and of the French and English Antarctic Expeditions, there are few, if those at Samoa and Batavia, which are situated near the Equator, are omitted. The paper deals with observations made by Berndt, professor at the Physical Institute of Buenos Aires. The result of a year's observations of potential gradient and number of ions per cm.^{3} near Buenos Aires, show that the former has a maximum in winter and a minimum in summer ; while the number of ions is greatest in spring and summer, least in late autumn and winter. Both elements are thus dependent upon the seasons in the same way as they are in the Northern Hemisphere : a result in contradiction to that obtained from Antarctic observations which made times of seasonal maxima and minima simultaneous all over the globe. The influences of meteorological changes are similar to those observed in Europe, except that rainfall was usually accompanied by a low positive potential gradient, rarely by a negative gradient. Diurnal variation of potential gradient is similar in character to the variation of northern latitudes. Observations were also made of conductivity, and velocity of positive and negative ions; and the air-earth current was deduced. The electricity brought down by rain was also measured and the results summarised. R. C.

DISCHARGE AND OSCILLATIONS.

1857. *Ionisation in Gaseous Mixtures by Röntgen Radiation.* **L. Simons.** (Univ. of Durham Phil. Soc., Proc. 5. pp. 33–44, 1912–1913.)—Barkla and the author have given results of ionisation experiments with air, H_2, O_2, CO_2, H_2S, SO_2, and with the vapours C_2H_5Br, and CH_3I. [Abstract No. 900 (1912).] In the present paper experiments are described on mixtures of some of these. It is shown that the ionisation produced by silver X-radiation in a mixture of H_2S and O_2 in equal parts is 1·17 times that in a mixture of SO_2 and H_2. Since the absorption by these two mixtures is the same ($\mu = 0{\cdot}0089$) the results show that ionisation is not atomic. In further experiments the author studies the ionisation in mixtures of ethyl bromide vapour with H_2, air, or SO_2. The results show that the kathode radiation from the Br produces the same number of ions in C_2H_5Br, H_2, air, or SO_2 for the complete absorption of its energy. E. M.

1858. *Recombination of Ions produced by Röntgen Rays.* **H. Thirkill.** (Roy. Soc., Proc. Ser. A. 88. pp. 477–494, July 1, 1913.)—The work of Bragg and Plimpton has shown that certain peculiarities occur in the initial stages of recombination. It was the author's aim to measure the coefficient when the initial peculiarities have been dissipated, these being the only conditions under which the coefficient has a simple meaning. The method employed is a modification of that of Langevin, the gas between two electrodes being ionised by a single flash of X-rays, and the calculation of the coefficient of recombination based on measurements of the current passing through the gas for different electric fields. It is shown that in these circumstances the distribution of the ionisation is unimportant, and also that the effect of diffusion is negligible. The measurements were made with air, CO_2 CO, SO_2, and N_2O under very varied conditions as regards intensity of ionisation, pressure, etc., and the results show that recombination takes place according to the simple law $dn_1/dt = dn_2/dt = -\alpha n_1 n_2$, where n_1 and n_2 are the numbers of positive and negative ions per c.cm. and α is the coefficient of recombination. For all the gases examined, and over a range of pressure of 200–760 mm. Hg the coefficient of recombination is shown to be proportional to the pressure. E. M.

1859. *Photoelectric Effect and Planck's Quantum.* **P. Debye** and **A. Sommerfeld.** (Ann. d. Physik, 41. 5. pp. 873–930, Aug. 5, 1913.)—An elaborate and highly mathematical treatment of the theory of the photoelectric effect from the standpoint of the universal Planck's quantum h. It is at the outset assumed that this quantum is a general property of all purely molecular processes of the emissive or absorptive kinds. Thus for the photoelectric effect it is stated as follows:—An atom accumulates incident radiant energy in the motion of its electrons until the quantity of the action

$\int(T - U)dt$ reaches the value $h/2\pi$, where (as in the principle of least action in mechanics) T is the kinetic, U the potential energy of the electron under notice (here the energy of the quasi-elastic connection) h is the constant of the radiation law. When the action first reaches the value $h/2\pi$, the electron is set free from its atomic connection with the kinetic energy T.

The body of the paper is divided into two parts, treating respectively of monochromatic and natural light. E. H. B.

1860. *Experiments on Columnar Ionisation.* **E. M. Wellisch and J. W. Woodrow.** (Amer. Journ. Sci. 36. pp. 214–230, Sept., 1913. Phil. Mag. 26. pp. 511–523, Sept., 1913.)—In a paper by Wellisch and Bronson [Abstract No. 1089 (1912)] a theory was put forward to explain the difficulty of obtaining saturation in the case of α-ray ionisation, the assumption being that an α-particle produces "neutrons" or unstable systems which are subsequently resolved into ions, probably by collision with ions already established. The present experiments were undertaken to test this point, the principle being that in the above theory it is to be expected that when the electric force is sufficiently great the electric current would be slightly greater when the field is longitudinal, or parallel to the α-particle column, than when it is transverse or perpendicular to it. The results confirm the accepted view of the phenomenon as advanced by Langevin and Moulin, namely, that "lack of saturation" of the ionisation current is due to columnar recombination, and no evidence was obtained which would indicate the existence of unstable atoms in the α-ray columns. The mean radius of the ionisation columns round the track of an α-particle is estimated as 0·0021 cm. E. M.

1861. *Fluctuations in Ionisation due to γ-Rays.* **P. W. Burbidge.** (Roy. Soc., Proc. Ser. A. 89. pp. 45–57, Aug. 1, 1913.)—The experiments described are a continuation of those of Laby and Burbidge [Abstracts Nos. 1350 (1911), 1221 (1912)], in which the existence of fluctuations in the ionisation due to γ-rays from radium was demonstrated. The author has obtained photographic records of the ionisation due to γ-rays, and estimated the value of the absolute fluctuation. The absolute fluctuation was calculated from Campbell's formula $\overline{\Delta^2} = 2\overline{\delta^2}C/e^2s^2R$, where $\overline{\delta^2}$ is the mean-square deviation of the image of the electrometer fibre, C the capacity of the system in cm., R is the resistance in e.s. units between the fibre, etc., and the earthed surroundings, s the sensitiveness per e.s. unit of voltage, and e the elementary charge. [See Abstract No. 678 (1910).] The fluctuation was found to be almost proportional to the ionisation when either the solid angle of rays used or the gas in the ionisation vessel was varied. The results are discussed on the various theories of γ-rays, and appear to lead to the deduction that a γ-ray is an entity in the sense that it has a discontinuous wave-front. E. M.

1862. *Rays of Positive Electricity.* **J. J. Thomson.** (Roy. Soc., Proc. Ser. A. 89. pp. 1–20, Aug. 1, 1913.)—It is first shown that all the particles which have a given value of e/m strike the plane on a parabola, which latter can be photographed by allowing the particles to fall on a photographic plate. The apparatus and the conditions for obtaining photographs of these parabolas is next considered, together with the interpretation of the photographs. Using the method described, it is possible to distinguish between the following classes: Positively electrified atoms with one charge, positively electrified molecules with one charge, positively electrified atoms with multiple charges, negatively electrified atoms, and negatively electrified molecules. There seems to be strong evidence that the charged atoms and molecules are produced by different agents. The photographs show that at certain places in the dark space there may be great changes in the production of charged molecules without any changes in the production of charged atoms. Another argument in favour of this view is the great variation that occurs in the relative intensities of the lines due to the atoms and molecules of the same element when the conditions of discharge are slightly altered. It is concluded that moving positively-charged atoms and molecules are in the main responsible for the dissociation which produces the positively-charged atoms occurring in the positive rays. The rarity of the double-charged molecule seems to indicate that the shock which produces the double charge is sufficiently intense to dissociate the molecule into atoms. The uniformity of the intensity of the parabolas corresponding to the multiply-charged atoms show that they acquire this change at one operation and not by repeated ionisation on their way to the kathode. The occurrence of the multiple charge does not seem to be connected with the valency or the chemical property of the atom. The fact that these multiple charges so frequently occur on atoms of the inert gases tends to prove that they are not produced by any process of chemical combination. All the results point to the conclusion that the occurrence and magnitude of the multiple charge is connected with the mass of the atom rather than with its valency or chemical properties. No instance has been found where a molecule of a compound gas acquires a negative charge, and only two where a molecule of an elementary gas does so, viz., oxygen and carbon. The conditions which regulate the appearance of the negatively charged carbon molecule are very interesting. The negative molecule does not occur in compounds like marsh gas. CO_2, CO, phosgene, and so on, where there is no linking between the carbon atoms. On the other hand, it does occur with compounds like acetylene, ethylene, ethane, where there are two carbon atoms linked together by one or more bonds. Since each parabola on the photograph indicates the presence in the discharge tube of particles having a known value of m/e, and as we can determine by the methods described what multiple e is of the unit charge, it is possible, by measuring the parabolas, to determine the masses of all the particles in the tube, and thus identify the contents of the tube so far as this can be done by a knowledge of the atomic and molecular weights of all its constituents. Thus it is shown that there can be little doubt that what has been called neon is not a simple gas but a mixture of two gases, one of which has an atomic weight about 20 and the other about 22. The parabola due to the heavier gas is always much fainter than that due to the lighter, so that probably the heavier gas forms only a small percentage of the mixture.

With reference to X_3, though the largest quantites of that substance are obtained by bombardment with kathode rays, this is by no means the only source of the gas. It and helium are obtained when the discharge from a Wehnelt kathode passes through an exhausted tube. The most obvious suggestion, that it is a carbon atom with four charges of electricity, is shown to be not tenable. If X_3 does not contain a new element and is not carbon with four charges it must be triatomic hydrogen. From the physical side there is considerable evidence in favour of this view. The chemical properties of X_3, however, in no way suggest hydrogen, so that if it is manufactured from that gas its relations to hydrogen must be very different from those of ozone to oxygen. The properties of X_3 brought to light by these experiments are: It can be kept over mercury for several weeks, though it is diminished in amount at the end of that time; it can be heated in a quartz tube for several hours without any appreciable change, although the quartz is at a red heat; it can be sparked with oxygen and also with phosphorus without being destroyed; it is not affected when passed over cold metallic sodium and when heated with sodium vapour it does not combine with it; it can withstand the action of red-hot copper oxide and potash. These properties point to its being a very inert substance, and are not those we should expect an allotropic form of hydrogen to possess. There are, however, two cases where it enters into chemical combination: it combines with mercury-vapour when an electric discharge is sent through the mixture, and it combines, to some extent, with red-hot copper. Also X_3 is found to disappear when a mixture of it with hydrogen is sparked with sufficient oxygen to give a violent explosion. These properties point to the conclusion that if X_3 is an element it has considerable resemblance to the inert gases He and Ar, although its chemical properties are slightly more energetic. The absence of parabolas corresponding to $m/e = 1{\cdot}5$ and $m/e = 6$ shows that if it is an element it is monatomic. Mendelejeff predicted the existence of an element of atomic weight 3 and attributed to it properties similar to those of fluorine, but of greater intensity. The chemical properties of X_3 are much too lethargic to be consistent with the view that it is a kind of super-fluorine. If X_3 is related to such an element, that element must have atomic weight 2 and not 3, and X_3 must be a stable compound of it with hydrogen. If this were the case, since the line corresponding to the element would coincide with that due to the hydrogen molecule, which is always on the plate, it would be difficult to get, by the study of the lines due to the positively charged particles, evidence as to its existence. Again, a substance possessing the energetic chemical properties of Mendelejeff's element should be able to attract a negative charge, and there should be on the negative side of the photographs a line for which $m/e = 2$. No such line has been detected. It has been proved in subsequent experiments that when the salts of Li, Na, K, or Rb are bombarded by kathode rays there is a genuine production, as distinct from liberation of absorbed gas, of He and X_3, potassium giving the largest supply. This is of interest since potassium, as Campbell has shown, is radio-active. It is further shown that X_3 liberated from dissolved salts is not simply absorbed by them, but is either manufactured from hydrogen in the presence of water or liberated from the atoms of one or more of the elements in the salt, and that the presence of water is an important, it may be an essential, condition for the production by atomic disruption. If we suppose that X_3 is made from hydrogen, the function of the salt may be merely to supply the necessary water in a convenient form. X_3 is produced when the discharge from a Wehnelt kathode passes through gas at a low pressure, though in this case the bombardment of the walls of the tube by the kathode rays is feeble: this and its sporadic appearance in discharge tubes would be accounted for if it were produced from water-vapour. A. E. G.

1863. *Number of Elementary Charges on Gaseous Ions.* **P. Langevin.** (Le Radium, 10. pp. 113–118, April, 1913.)—Townsend first showed that from a knowledge of the ratio of the mobility and diffusion coefficient of ions the ratio of the charges on the ions to the elementary charge could be calculated. His results showed that while negative ions were always singly charged, positive ions produced by penetrating X-rays were generally doubly charged [Abstract No. 662 (1908)]. The present paper deals with a direct method of measuring k/D (k = mobility, D = diffusion coefficient) for either positive or negative ions. If two electrodes are very near together and the gas between is ionised by β- or γ-rays passing normal to the electrodes, then ions are produced practically uniformly and recombination may practically be neglected. From a consideration of these conditions the author shows that from the current potential curve k/D for both sets of ions can be evaluated. In particular if both positive and negative ions are singly charged, the curve is given by $i/I = (e^m + 1)/(e^m - 1) - 2/m$; here $m = kv/D$, I is the saturation current and i the current at potential V. Measurements by Salles appear to indicate that this equation holds and that both sets of ions are singly charged.

E. M.

1864. *Matter in its Electrically Explosive State.* **F. E. Nipher.** (Amer. Philosoph. Soc., Proc. 52. pp. 283-286, April, 1913.)—Singer in 1815 pointed out that a lead wire 0·01 in. in diam. could be exploded by passing an electrical discharge along it under suitable conditions. The present paper describes a variation of the experiment in which a condenser (of twenty sheets of glass 66 cm. square with tin-foils each 30 cm. square) was charged by an influence machine and then discharged through a ¼-amp. fuse wire of diam. 0·115 mm. This wire was contained in a glass tube, 10 cm. long and 1 or 2 mm. bore, filled with coal-oil, all air being excluded. The leading-in wires practically filled the ends of the tube which were sealed with sealing-wax. A single discharge from either the positive or the negative side of the condenser, through the wire to earth, caused the tube of glass to be shattered into fragments so minute that their impact on the observer's face 6 ft. away produced no harmful effect.

E. H. B.

1865. *Silent Electric Discharges through Gases at Atmospheric Pressure.* **E. H. Riesenfeld.** (Festschrift W. Nernst, pp. 374-382, 1912.)—Continuing his work on the subject [Abstract No. 1609 (1911)] the author has determined the minimum potential required for passage of the silent discharge through the gases H, O, CO_2, and N, and its dependence on the dimensions of the "ozoniser," the nature of the glass, and the frequency of the alternating current. The minimum potentials for these gases, referred to H as standard, are not invariable, but the relative values increase with increasing size of the "ozonizer," and fall with increasing frequency of alternation. With quartz glass no silent discharge can be obtained, due probably to its insulating properties. The minimum potential for the silent discharge is distinctly lower than the sparking potential in continuous-current discharge, but the order of the gases, arranged according to minimum potential, is the same in both cases. The silent discharge through O and CO_2 is accompanied by hysteresis effects, so that their minimum potentials can only be obtained by gradually lowering the applied potential.

W. H. St.

1866. *Peculiar Form of Low-potential Discharge in the Highest Vacua.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 89. pp. 68-74, Aug. 1, 1913.)—The curious electrical effect described by Phillips [see Abstract No. 320 (1902)] is shown to be due to a residual positive static charge on the inner surface of the glass arising from the preliminary induction coil discharge between the iron electrodes at the centre of the bulb. This sets up a p.d. between the glass surface and the iron electrodes, which, upon the establishment of the magnetic field between the electrodes, causes a visible discharge lasting about 8 secs. The magnetic field simply reduces the p.d. required for the discharge. The author describes an experiment in which a continuous discharge of a similar character is effected by an electrostatic machine, the kathode being a brass cylinder immersed in a magnetic field parallel to itself and the anode a concentric gauze cylinder. There is no discharge even with a p.d. exceeding 12,000 volts when the magnet is turned off, but 800 volts suffices to effect the discharge when the magnet is on. The electrons are considered to be sent by the electric and magnetic fields from the kathode to the anode in a spiral path whirling round the kathode. In this way they travel through a distance sufficient to ionise the gas without having to fall through a large p.d. An additional experiment bears out this explanation. F. J. H.

1867. *Simple Theory of Coupled Oscillatory Circuits, with Illustrative Oscillograms.* **J. A. Fleming.** (Phys. Soc., Proc. 25. pp. 217–226; Discussion, p. 226, June, 1913.)—The author gives a very short method, involving only the simplest algebra, for arriving at a formula for the time of free electrical oscillation of a leaky condenser in series with an inductive resistance, the oscillations being damped. The amplitude of the oscillations is proportional to the real part of ϵ^{jPt}, where $P = p + ja$ and $p = 2\pi n$, n being the frequency and a the damping coefficient. Hence the volt drop down the resistance is $R + jPL$, and that down the condenser is $(S + jPC)^{-1}$. The sum of these two is zero, which leads at once to the equation—

$$P = p + ja = j\left(\frac{R}{2L} + \frac{S}{2C}\right) \pm \sqrt{\frac{1}{CL} - \left(\frac{R}{2L} - \frac{S}{2C}\right)^2},$$

giving the frequency and damping. The formulæ are confirmed by oscillograms taken at low frequency with a Duddell oscillograph. In the same manner the case of coupled circuits is considered and the e.m.f. equations are written in the form $Tim_1 I_1 + jMP_2 I_2 = 0$, $jMP_1 I_1 + Tim_2 I_2 = 0$, where Tim stands for $(R + jPL) + (S + jPC)^{-1}$. Eliminating the currents I_1 and I_2, we have an equation which can be solved for p. Taking the reduced case of non-leaky condensers, tuned circuits, and zero resistance in the secondary, the equation deduced is—

$$[p^2CL(1 - k) - 1][p^2CL(1 + k) - 1] - a_1{}^2CL[1 - (1 + k^2)p^2CL] = 0,$$

which shows that there are, in general, oscillations of three frequencies in the circuits. This is confirmed by oscillograms. T. P. B.

1868. *Beaded Character of Kathode-ray Line.* **C. T. Knipp.** (Phys. Rev. 2. Ser. 2. pp. 39–48, July, 1913.)—The so-called magnetic spectrum of kathode rays has generally been considered to be due to the want of uniformity necessarily associated with the use of an induction coil. Recent experiments by the author suggest that the origin of the beaded character of the kathode-ray line may possibly be other than a want of uniformity accompanying the induction coil or static machine discharge. The apparatus used was the same as previously employed [Abstracts Nos. 555 and 1091 (1912)] with slight modifications. The Wehnelt kathode was removed and an ordinary Al kathode suitably mounted. The beam of kathode rays emergent from the canal passed between the nearly coterminous magnetic poles and electrostatic field plates and fell on the photographic plate beyond. This range was about 2 cm. After connecting the winch for turning the plate the containing vessel was sealed and evacuated. To get instantaneous photographs it was only necessary to rotate the plate while the discharge was passing. It appears from the photographs reproduced that in most cases the beaded effect of the kathode-ray line may be accounted for by the oscillatory character of the electric discharge. However, a number of the photographs show beads whose spacing along the kathode line is not in agreement with that which should follow for damped oscillations. These may be due to ionisation or secondary effects, or possibly to group-velocity electrons given off by the kathode. The position of the kathode seems to have little or no effect upon the general character of the beads. The strongest evidence pointing to the oscillatory discharge as the origin of the beads is furnished by the photographs showing the negative crests. These crests in almost every instance correspond to the troughs in the beaded line. Assuming that the evidence submitted is sufficient to show that an oscillatory discharge under proper conditions results in a beaded kathode line, it seems that we have here a possible explanation of the beading of J. J. Thomson's molecular lines.

A. W.

1869. *Behaviour of Mercury Arc Rectifier under Alternating Current of High Frequency.* **H. Busch.** (Phys. Zeitschr. 14. pp. 524–528, June 15, 1913.)—The object of the investigation is to see whether the mercury arc behaves in the same manner for high-frequency as for low-frequency alternating current. This is found to be the case, and it is shown that a mercury rectifier with the ordinary connections can be driven by oscillations of over 2×10^5 per sec. A new and simplified method of connecting the rectifier is described, which may be used both for high and low frequency, and also for obtaining an alternating current of double the frequency of the original current.

T. P. B.

1870. *Generator of Short Electric Waves.* **F. F. Martens** and **I. Ganswindt.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 557–559, July 15, 1913.)—Instead of a Hertz-linear sender the authors use two coaxial metal cones with the apices towards each other. The discharge takes place between the points of the cones through a stream of paraffin. Direct current at 440 volts or alternating current of frequency varying from 50 to 100,000 per sec. is used to excite the sender. The wave-length is 30 cm. The character of the oscillation is investigated by a Braun tube placed in the electric field of the oscillator. With alternating current at 50 ∿ per sec., if the points of the cones are so far apart that no current passes, the usual sine curve is observed. But if the points are brought so near that discharge takes place, a zigzag is observed with rectangular bands at the points of the zigzag. These rectangular bands signify a radiation of constant amplitude and in each train there are about 7×10^6 waves. T. P. B.

1871. *Atmospheric Refraction in Wireless Telegraphy.* **W. H. Eccles.** (Electrician, 71. pp. 969–970, Sept. 19, 1913. Paper read before the British Assoc. at Birmingham.)—A paper in which theory is developed to explain the bending of electric waves round the earth on the ground of the varying ionisation of the atmosphere. The fundamental theorem is that the velocity of electric waves through a gas is increased by the presence of ions of molecular size in the gas [see Abstract No. 1192 (1913)]. The velocity of long electromagnetic waves will thus exceed the velocity of light in an ionised medium. It is explained in a simple manner how this is the case. The trajectory of rays in an atmosphere, in which the index of refraction varies in a particular manner with the distance from the centre of the earth, is then examined. The theory gives a result which does not agree very well with the result which Austin and Cohen's empirical formula furnishes, but the absorption is supposed to be nil, and the assumed variation of the refractive index probably only roughly represents the truth. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1872. *Attainment of High Potentials by the Use of Radium.* **H. G. J. Moseley.** (Roy. Soc., Proc. Ser. A. 88. pp. 471–476, July 1, 1913.)—A radioactive substance which emits β-radiation should, when insulated, continue to gain a positive charge until it attains a potential V such that the energy of the emitted β-rays is equal to V*e*. For radium emanation in equilibrium with its active deposit this potential is of the order 10^6 volts. The author has made experiments to test this point. A small bulb containing RaEm was supported by a quartz rod at the centre of a highly exhausted flask. A disc suspended from a quartz spring in the neck of the flask formed a simple attracted-disc electrometer. It was found that a bulb of 9 mm. diam. reached a potential of 160,000 volts in the course of a few minutes. A sudden discharge then occurred through the residual gas in the flask. A bulb of 5 cm. diam. charged up more slowly; no discharge took place and the final potential, 110,000 volts, was limited by a leak of electricity along the quartz support. The experiments thus provide a striking direct proof of the large amount of energy involved in the expulsion of a β-particle. The author also gives a discussion of the insulating powers of a vacuum. E. M.

1873. *Method of Counting α- and β- Rays.* **H. Geiger.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 534–539, July 15, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—Rutherford and Geiger in a previous paper [Abstract No. 246 (1913)] have described an apparatus for counting the α-particles emitted by radio-active substances. The present paper gives particulars of an arrangement of great simplicity and sensitiveness by which β-rays also may be counted. A brass tube about 2 cm. diam. and about 4 cm. long is closed at one end by an ebonite stopper through which a wire passes, lying along the axis of the tube and having a fine point. The point of the wire is distant about 0·8 cm. from the disc which closes the end of the tube. Through a small hole in the centre of this disc the rays to be counted can enter the ionisation chamber. The tube walls are charged to a positive potential of about 1200 volts, while the wire is connected up to a string electrometer. With this arrangement the kicks of the electrometer due to the entrance into the ionisation chamber of a single α- or β-particle correspond to potentials of from 10 to 20 volts. Examples are given of the use of the apparatus for counting the particles from a polonium preparation emitting about 4000 α-particles per sec. Reproductions are given of the photographic records. A. W.

1874. *Experimental Proof of the Existence of Electric Dipoles in Liquid Dielectrics.* **S. Ratnowsky.** (Deutsch. Phys. Gesell., Verh. 15. 12. pp. 497–516, June 30, 1913.)—Debye [Abstract No. 571 (1912)] assumes that in the interior of insulators there are not only elastically-bound electrons but also dipoles of constant electric moment. From the results of his measurements of the dielectric constant of a 20 per cent. solution of amyl alcohol in benzene the magnitude of the moment of a dipole is calculated to be $m = 1{\cdot}81 + 10^{-19}$, which is of the same order of magnitude as that calculated by Debye from the variation of the dielectric constant with the temperature. T. H. P.

1875. *Shape of the Ideal Electrocapillary Curve.* **F. Krüger** and **H. Krumreich.** (Zeitschr. Elektrochem. 19. pp. 617–622, Aug. 15, 1913.)—According to the thermodynamical theory of Lippmann-Helmholtz, the electrostatic repulsion of the double-layer charge determines the change in the surface tension of the mercury, and $\partial\gamma/\partial E = -\epsilon$, where γ is the surface tension, E the p.d. reckoned from the maximum of the curve as zero, and ϵ is the areal density of the charge. To integrate, some assumption as to the capacity of the double layer has to be made. Regarding its electrode as a condenser of constant capacity, Lippmann put $\epsilon/E = C$, and thus found that $\gamma = \gamma_{max.} - CE^2/2$; that is to say, the curve should be a parabola. But the recent studies of polarisation capacities do not indicate that an electrode behaves as a condenser of constant capacity; the changes in the concentration at the electrode can, however, be calculated after Nernst, $E = RT \log (C/c)$. Even with this modification the curves are not found to be parabolas, the ascending (negative) branch always being steeper than the descending branch. Taking, however, the capillary electrometer of S. W. J. Smith (1900), and as electrolyte potassium nitrate with or without mercurous nitrate, and making the capillary very fine, 18 μ, the authors find that the curve does not differ from a parabola by more than 1 per cent. maximum. The capacity of the double layer is 27 mfd./cm². Other curves differ the more, the greater the tendency to complex formation in the mercurous salts, and the smaller the solubility of these salts, as Gouy had shown. H. B.

1876. *Thermoelectric Properties of some Irreversible Nickel aud Manganese Steels.* **S. Hilpert** and **F. Herrmann.** (Zeitschr. Elektrochem. 19. pp. 215–219, March 1, 1913.)—Rods of steels 4 mm. in diam. were prepared containing 12·6 or 27·5 % Ni and 4·58, 11·7, 20·8 % of Mn, and were coupled with rods of constantan or of copper; they were then tested for thermo-electricity and magnetism at temperatures from +600° down to −186° C. The 27·5 % Ni steel behaved as regards thermoelectric hysteresis like a ferro-magnetic metal; the manganese sheets resembled magnetically the 12·6 % Ni steel, but showed no noteworthy changes in these thermoelectric forces at different temperatures. H. B.

1877. *Vibration Galvanometers.* **H. F. Haworth.** (Phys. Soc., Proc. 25. pp. 264–271; Discussion, pp. 271–272, June, 1913.)—(1) The maximum power available for vibrating the moving system of a vibration galvanometer of the moving-coil type is $V^2/4R$. As the frequency of the instrument is raised the losses increase rapidly, so it is an advantage to be able to increase the useful power input per unit voltage. To do this the resistance of the instrument must be decreased. This can be done in a galvanometer of the Duddell type by leading the current in and out at the bottom bridge and short-circuiting the wires at the top bridge. This results in a great increase of sensibility. A lower resistance also requires a lower flux-density. (2) Owing to the losses in the moving system increasing at a greater rate than the first power of the frequency, and to the fact that the frequency of the system increases at a slower rate than the reciprocal length of the string on account of the mass of the mirror, the flux density must be increased as the frequency increases, in order that the back e.m.f. of the moving system may always be half that of the applied p.d. (3) A combination of (1) and (2) makes a very satisfactory instrument with a much flatter voltmeter sensibility-frequency curve than usually obtained. [See Abstract No. 1487 (1912).] E. H. B.

1878. *An Electric Converter.* **W. I. Book.** (Phys. Rev. 2. Ser. 2. pp. 49–57, July, 1913. Electrical World, 62. p. 898, Aug. 23, 1913. Abstract.)—The converter is designed to furnish high-frequency oscillations from a d.c. supply. The d.c. supply at 500 volts is made to send a spark through an air-gap between a circular disc and a concentric flat ring. The spark is caused to rotate round the gap by a magnetic field at right angles to the disc, and to secure the conditions for oscillations the ring is notched with about 10 notches per cm. A capacity and self-induction are connected across the spark-gap and, as the spark in passing round the gap alternately meets a maximum and minimum resistance in the notches, there is an alternating ebb and flow of energy in this circuit, setting up oscillations. The effects of varying the primary current, magnetic field, capacity, etc., are investigated, and the converter is stated to have been successfully used in wireless telegraphy. T. P. B.

ALTERNATING CURRENTS AND MAGNETISM.

1879. *Magneto-optical Parameters of Iron and Nickel.* **C. Snow.** (Phys. Rev. 2. Ser. 2. pp. 29–38, July, 1913.)—Voigt's theory makes all types of Kerr and Faraday effects depend uniquely on the value of a certain complex parameter of the metal. An expression for the equatorial magnetic rotation is obtained, as a consequence of Voigt's theory, which is in good accord with the recent experiments of Ingersoll. The magneto-optical constants of iron and nickel have been computed from those experiments and from those of Foote. Formulæ for the magnetic rotation and ellipticity for the transmitted light have been obtained, and the amounts of the Kerr and Faraday rotation and ellipticity computed for yellow light. These are in close agreement with accepted values. The relative dispersion of these two rotations has been computed for a spectral range from 0·4 μ to 2·1 μ, and is in fair agreement with all the experimental results which have thus far been obtained for iron and nickel. G. E. A.

1880. *Magnetic Materials in Claywares.* **A. Hopgood.** (Roy. Soc., Proc. Ser. A. 89. pp. 21–30, Aug. 1, 1913.)—An account is given of the observations on burnt clays, beginning with those of Boyle in 1691. In recent work [see Abstract No. 1506 (1900)] it is assumed that baked clays owe their magnetic properties entirely to the presence of magnetic oxide of iron, and that this is derived partly from the orientation of the magnetite originally present in the clays, and partly from the reduction of the ferric oxide of the clays during the process of burning. This view is considered too limited, and observations are detailed which show that white, cream, grey, yellow, buff, red, and brown claywares are feebly or moderately magnetic owing to the presence of black unfused grains of unchanged magnetic minerals and bluish-black fused globules of ferruginous silicates. Analysis of the magnetic globules indicates the presence of about 32 per cent. of ferrous iron in them. All baked claywares are magnetic, and great care must be exercised in the choice of these materials for use in magnetic observatories. G. E. A.

1881. *Hall-effect in Liquid Electrolytes.* **A. E. Oxley.** (Roy. Soc., Proc. Ser. A. 88. pp. 588–604, July 18, 1913.)—The behaviour of solutions of copper sulphate, silver nitrate, and cadmium sulphate, and of copper sulphate gel has been studied in direct and reversed magnetic fields by means of a delicate Paschen galvanometer. In order to ensure the uniformity of the magnetic field use was made of cells having areas very small (4 cm.^{2}) in relation to that of the pole-pieces (50 cm.^{2}); with the same object, the magnitude of the air-gap was reduced as far as possible. It is found that the Hall concentration effect contributes the greater proportions of the p.d.'s observed, the true Hall-effect being included. This preponderance of the concentration effect, depending on the sum of the ionic velocities of the electrolyte, prevents information being obtained regarding the nature of the process of reversal, such as was hoped for from an examination of electrolytes whose differences of ionic velocities vary considerably. In the eight experiments made, the p.d.'s are all of the calculated order, while they reverse with the magnetic field and act in the same direction under widely varying experimental conditions. These results are regarded as establishing the existence of a Hall-effect in liquid electrolytes. T. H. P.

1882. *Force Exerted on a Magnetic Particle by a Varying Electric Field.* **J. G. Leathem.** (Roy. Soc., Proc. Ser. A. 89. pp 81–85, Aug. 1, 1913.)—Modern theory, which explains magnetism as a purely electrical phenomenon, defines magnetic force as a solenoidal vector whose curl is 4π times the electric current. It is considered an essential part of the test of the theory that the definitions should be justified by ascertaining the theoretical value of the force exerted on a magnetic particle by a varying external field. The expression found for the force contains the ordinary formula plus a second term which represents a mechanical force exerted on a magnet by a current of æthereal displacement. G. E. A.

1883. *Method of Measuring Magnetic Permeability.* **W. H. F. Murdoch.** (Electrician, 71. pp. 976–977, Sept. 19, 1913. Paper read before the British Assoc., Birmingham, Sept., 1913.)—Description of a test carried out by means of the unipolar magnetometer method, and suggestion of an instrument based on this principle. G. E. A.

1884. *Artificial Magnetic Storm.* **F. E. Nipher.** (Science, 37. p. 836, May 30, 1913.)—Reference is made to a previous paper in the same journal, in which evidence was presented to show that atmospheric ions tend to set like magnets along the lines of the earth's magnetic field. The effect of gusts of wind in disturbing these ions was also pointed out. An artificial local storm can be produced as follows: Place two bar magnets on opposite sides of a delicately suspended needle provided with mirror, telescope, and scale. Place a plate of glass over one magnet and sprinkle iron filings on it. The deflecting effect of that magnet is increased, and is balanced by moving the other magnet. Disturb the iron filings by means of a brush applied to any small area of the plate, and a magnetic storm is thus produced to which the needle responds. The daily variation in the earth's field may be explained as due to the change in permeability brought about by ionisation of the air by sunlight. G. E. A.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1885. *New Current Interrupter for Spark Inductors.* (Electrotechn. Zeitschr. 34. p. 1065, Sept. 11, 1913.)—An interrupter known as "Eresco-Rythmeur" in which a number of carbon contacts are substituted for the usual Hg contact. It is claimed that with a current of 40 amps. and voltage of 440 for one hour the contacts do not deteriorate. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1886. *Density aud Atomic Weight of Helium.* **W. Heuse.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 518–523, July 15, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—Helium was obtained from thorianite and purified by the usual method, after which the density was determined by weighing, using a glass counterpoise of about the same weight and volume as the vessel containing the gas. The weight of a normal litre of helium, as a mean of seven experiments, is found to $0{\cdot}1785_6 \pm 0{\cdot}0000_8$ gm., from which the atomic weight is calculated to be 4·002. [See Abstract No. 2224 (1905).]

T. S. P.

1887. *An Oxidisable Variety of Nitrogen.* **T. M. Lowry.** (Faraday Soc., Trans. 9. pp. 189–192, July, 1913.)—A supplement to the paper noticed in Abstract No. 1591 (1912). Andreoli ozonisers are combined with groups of spark-gaps so that the air is exposed to the silent discharge and also to a spark discharge between pairs of iron studs; the sequence of the two discharges can be reversed, and the gases be examined after having undergone one treatment or the combined treatment. The spectra obtained with the aid of a wooden trunk, 3 in. square, 64 ft. (or 15 ft.) in length, are now reproduced. The conclusion is drawn that the ozone oxidises a modified nitrogen to peroxide, though Strutt could not oxidise his active nitrogen by ozone under the conditions of his (Strutt's) experiments. In the technical fixation of nitrogen the chief feature would appear to be to produce the disrupted active nitrogen and to bring it in contact with atomic or ozonised oxygen before it reverts to the inactive form.

H. B.

1888. *Adsorption by Heated Charcoal.* **K. Arndt** and **G. Schraube.** (Festschrift W. Nernst, pp. 46–52, 1912.)—Carbon dioxide and CO are shown to be both adsorbed by carefully purified wood charcoal, Co_2 being the more readily adsorbed, and the volume ratio of the adsorbed gas being, at the ordinary temperature, 3·4 : 1. If the gas adsorbed by charcoal from a mixture of CO_2 and CO is removed in successive fractions, the ratio of CO_2 to Co increases very considerably in the later fractions, a similar variation in the ratio being also found in the successive fractions obtained from charcoal placed in CO_2 for several hours at 750–800°, indicating that the adsorbed gas is under considerable pressure, which tends to displace the equilibrium between C, CO, and CO_2 in favour of the CO_2. Similar results are obtained by placing the charcoal in a mixture of CO_2 and N at 200°, 300°, and 400°.

W. H. Si.

1889. *Absorption of Active Hydrogen by Platinum.* **A. E. Freeman.** (Amer. Chem. Soc., Journ. 35. pp. 927–931, Aug., 1913.)—The use of a Hale-Pirani vacuum manometer has led to the observation of various phenomena difficult of explanation. This manometer consists of Pt-wire, 1·1 mil in diam., mounted on glass supports and sealed in a thin-walled glass bulb, a constant current of about 0·00925 amp., taken from a special storage battery being sent through the wire which is thus heated to about 125°. At low pressures the equilibrium temperature of the wire, and therefore its resistance, is a function of the gas pressure. The manometer is calibrated by taking the resistance of the wire at various pressures—as low as 0·00002 mm. of mercury—which are measured by a sensitive, accurate McLeod manometer. The calibration curve thus gives resistance of the wire in terms of the pressure and is a straight line below 0·0005 mm. The zero-pressure resistance is found by extrapolation.

In measuring the pressures in incandescent lamps it was found that, after a lamp had been burning for about 50 hours, the zero-pressure resistance was often exceeded, a negative pressure being thus indicated. In view of the theory propounded by Langmuir concerning the presence in incandescent lamps of the active modification of hydrogen formed by the decomposition of traces of water-vapour by the filament [see Abstracts Nos. 523, 891 (1913)], it seemed possible that the atomic hydrogen would recombine at the Pt filament and thus furnish heat to produce the abnormal action in the manometer. Interposition between the lamp and manometer of either a glass U-tube immersed in liquid air or a plug of glass wool prevented the appearance of the negative pressure, presumably owing to the adsorption of the active hydrogen. That the abnormally high resistance of the Pt is not, however, due to the heat developed by the recombination of hydrogen atoms is shown by the persistence of these negative pressures for 50 hours after the current is cut off from the lamp, and it seems probable that the absorption of the active hydrogen by the Pt causes the increased resistance of the latter. When air is let into the apparatus the specific resistance of the Pt falls to its original value, owing evidently to oxidation of the atomic hydrogen.

T. H. P.

1890. *Chemical Reactions at very Low Pressures.* II. *Chemical Clean-up of Nitrogen in a Tungsten Lamp.* **I. Langmuir.** (Amer. Chem. Soc., Journ. 35. pp. 931–945, Aug., 1913.)—Further investigation [see Abstracts Nos. 523, 891 (1913)] shows that nitrogen in a lighted tungsten lamp disappears in three ways: Chemically, electrochemically, and electrically, the chemical clean-up depending on the combination of the nitrogen with tungsten-vapour to form the brown compound WN_2. From zero pressure up to about 0·001 mm., the rate of chemical clean-up is proportional to the product of the rate of evaporation and the pressure of nitrogen, whilst from 0·003 to about 1 mm. the rate is proportional to that of evaporation and independent of the pressure; at pressures exceeding 2 mm. the rate is still proportional to that of evaporation, but the latter is reduced materially by the presence of the gas. At no temperature does nitrogen react perceptibly with solid tungsten. The rate of evaporation of tungsten *in vacuo* at any temperature T (Kelvin) is given by the equation, $\log_{10} M = 15{\cdot}402 - 47444/T - 1{\cdot}4 \log_{10} T$, where M is expressed in gm. of tungsten per sec. per cm.^{2} of surface. The vapour pressure of tungsten in mm. of mercury is given by the expression, $\log_{10} p = 15{\cdot}502 - 47444/T - 0{\cdot}9 \log_{10} T$, and at the melting-point (3540° K.) is 0·080 mm. The boiling-point of tungsten is in the neighbourhood of 5000° K. and the heat of evaporation is very high, namely, $\lambda = (218000 - 1{\cdot}8\,T)$ gm.-cals. per gm.-atom. As regards the mechanism of the reaction, the tungsten-vapour given off by the filament is monatomic, and when each atom of the vapour collides with a nitrogen molecule, it reacts with it to form WN_2, it being unnecessary for the nitrogen to be dissociated or ionised. Tungsten atoms striking the bulb do not react with a layer of absorbed nitrogen, possibly owing to the absence of such layer under the experimental conditions. The compound WN_2 has a clear, brown colour in thin layers and is decomposed by water to form ammonia and probably WO_3; it is stable in a vacuum at 400° C. but is decomposed at 2400° K. The electrochemical clean-up of nitrogen takes place at much lower temperatures (1900° K.) than the chemical, when potentials much over 40 volts are used in a way which causes a perceptible discharge through the gas; no fatigue effect occurs and the nitrogen in this case combines with tungsten to WN_2. The electrical clean-up proceeds at pressures of 0·005 mm. or less, with a voltage of 250 and high filament temperatures. It is very erratic and exhibits marked fatigue effects, sometimes with alternate evolution and clean-up of nitrogen as the temperature or voltage is varied. Part, at least, of the nitrogen is easily recovered by heating the bulb.

The behaviour of Pt towards oxygen is in every way analogous to that of tungsten towards nitrogen; at low pressures the oxygen combines with Pt-vapour to form PtO_2, but does not attack solid Pt. T. H. P.

1891. *Theory of Electrical and Chemical Atomic Forces.* **A. Byk.** (Deutsch. Phys. Gesell., Verh. 15. 13. pp. 524–533, July 15, 1913.)—The author puts forward a theory of the atom based on the assumption that in the interior of the atom non-euclidean geometry holds, and then discusses the application of the theory to the physics and chemistry of the atom. In the case of the alkali metals, Li, Na, K, and Rb, the ratios between the atomic radii and the distances apart of the atoms, as calculated by the formula deduced by the author, are found to be constant within 3 %, which lies within the limits of error. The heats of dissociation and the cross-sections of various molecules of the elements are calculated and compared with the experimental results.

T. S. P.

1892. *Studies on Sulphur, Selenium, and Tellurium.* **E. Beckmann.** (Preuss. Akad. Wiss. Berlin, Ber. 40. pp. 886–894, 1913.)—The cryoscopic constant of sulphur, as determined by measurements on solutions of naphthalene, diphenyl, aniline, etc., in sulphur, is found to be 213, from which the latent heat of fusion is calculated to be 14·1 cals. From these results, and the measurements of Smith and Holmes on the content of amorphous sulphur in sulphur which has been heated at different temperatures, the molecule of amorphous sulphur is calculated to be probably S_8. The author then puts forward a theory as to the molecular state of sulphur at different temperatures. Sulphur dissolves in iodine, without chemical combination, as the molecule S_8, whereas Se, in the same solvent, has the molecule Se_2. This dissociation of selenium is not a temperature effect, since in other solvents, at higher temperatures, the molecule is Se_8. Tellurium does not dissolve in iodine without chemical combination occurring. T. S. P.

1893. *Calcium Boride.* **E. Wedekind.** (Ber. Deut. Chem. Gesell. 46. 8. pp. 1885–1889, 1913. Chem. News, 108. p. 96, Aug. 22, 1913. Abstract.) —When calcium metaborate (80 gm.) is reduced with 50 gm. of calcium in the author's electric vacuum furnace (described in Ber. 46. pp. 1198–1207, 1913), CaB_6 is gained; extracted with acetic and hydrochloric acids and water the boride forms a fine brownish microcrystalline powder of density 2·11 at 18°; it superficially oxidises to borate when heated in air. When the arc plays between electrodes made of the compressed powder the boride, which conducts the current, sinters to a hard mass which cuts glass. The boride resists acids and alkalies, but is decomposed by fused caustic alkalies.

H. B.

1894. *Nickel Brasses.* **L. Guillet.** (Rev. de Métallurgie, 10. pp. 1130–1141, Sept., 1913.)—In Abstract No. 1819 (1906) the author's results were mentioned which led to equivalents for several metals in substitution for copper in the copper-zinc brasses containing from 55 to 68 % Cu; Abstract No. 1804 (1906) further deals with the data upon which the theory was based. In the present paper the importance of finding a metal which when added to the brasses has a negative equivalent is pointed out. Nickel appears to behave in this way, its coefficient *t* being —1·3. Four series of tensile, shock, and indentation tests, and photomicrographs, are given for alloys containing 50 and 55 % Cu, and 0 to 10 % Ni, as cast respectively in chills and in sand. The mechanical properties in all cases are the same as those of the Cu-Zn binary alloy which has the same structure, so long as the structure is not that of a Cu-Zn alloy beyond the limits 55 to 68 % Cu. This means that the addition of Ni is as advantageous as the addition of rather more Cu. Test results in two instances are also given for drawn, and drawn and annealed, nickel brasses, showing close agreement with the theory of equivalents. It is further pointed out that there is no need to reject nickel-plated pieces from among scrap from the brass foundry, so long as one is certain that the nickel hides nothing but brass. It appears that the fact that Ni forms an unbroken series of solid solutions with copper explains why Ni substitutes copper in the manner described. The author is investigating the general validity of this theory. F. R.

1895. *Hardness of Aluminium-Silver Alloys.* **G. Le Grix** and **W. Broniewski.** (Rev. de Métallurgie, 10. pp. 1055–1064, Aug., 1913.)—A brief review and bibliography of the work done on the hardness of alloys is given in the paper. The hardness of Al-Ag alloys has been studied by the Brinell method using a glass ball 1 mm. diam. under a pressure of 5 kg., and the results have been compared with the conductivity and temperature coefficient of electrical resistance of the same series of alloys. In addition to the hardness-volume concentration diagrams the authors have plotted softness-concentration curves, in which "softness" is defined as the faculty for undergoing permanent deformation and is represented numerically by the reciprocal of the hardness. These curves are similar to the conductivity and temperature-coefficient curves. The compound Al_2Ag_3 is sharply defined at a maximum on the curves, while the compound $AlAg_3$ corresponds to a discontinuity on the softness curve which also shows a discontinuity between these two points, corresponding with the micrographic change. As a result of their work the authors conclude that the study of hardness is not so precise as the thermal or electrical methods of determining constitution, but is very useful as an auxiliary method. F. C. A. H. L.

1896. *Action of Sulphur Dioxide on Copper at High Temperatures.* **C. M. Stubbs.** (Chem. Soc., Journ. 103. pp. 1445–1461, Aug., 1913.)—The depression of the freezing-point of copper by SO_2 was found to be about 2·54 times that expected if SO_2 were simply dissolved as such. This is explained upon the assumption of a partial reaction of the gas with the copper. The concentration varies as the square root of the pressure [see Abstract No. 800 (1911)]. If the reaction is about 70 per cent. complete at atmospheric pressure, the concentration varies as the square root of the pressure in the ratio found by Sieverts and Krumbhaar (*loc. cit.*). Such a partial reaction would give a depression about 2·4 times that calculated for the formula SO_2, which is in approximate agreement with the author's experimental value. These views are supported by the results of experiments on the influence of excess of Cu_2S or Cu_2O on the depression caused by SO_2. Results are given for the equilibrium pressures of SO_2 in the univariant system Cu, Cu_2O, Cu_2S (all solid), and SO_2, between 700° and 1050°, the pressure rising from a fraction of 1 atmo. to 7 atmos. Incidentally 1055° is deduced as the temperature of solidification of the triple eutectic of the three solids. The high value of the equilibrium pressure at this temperature, namely, 7 atmos., is in agreement with the very low solubility at ordinary pressures at the same temperature, noted in the Abstract already referred to. At the high temperatures and pressures it appears that the equilibrium may depend upon an influence of Cu_2S and Cu_2O upon each other's solubility. F. R.

1897. *Effect of Casting Temperature, etc., upon a Copper-Tin Alloy.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 31. 3. pp. 158–164, 1913.)—The alloys of the class Cu 95, Sn 4, and Zn 1 per cent. are occasionally brittle both as cast or as rolled. A tough and a brittle strip are sometimes obtained from the same crucible of metal. The results of some tests upon cast and rolled strips of the tough and brittle kinds are given. Repeated bending and one-blow shock tests show this difference. The fracture of the brittle metal showed blow-holes. The microscope showed the structure of the brittle specimens to consist mainly of a solid solution, which indicates slow cooling, due to too high a casting temperature or too hot a mould. The presence of the blow-holes confirms the probability of too high casting temperature. The resistance to shock was increased by cold working followed by annealing for half an hour at 600°. F. R.

1898. *Displacement of the Critical Points of Iron by Addition of Silicon.* **G. Charpy** and **A. Cornu.** (Comptes Rendus, 157. pp. 319–322, Aug. 4, 1913.)—Cooling-curves of seven mild steels (0·11 to 0·22 % C) containing 0·11 to 6·10 % Si, have been taken by means of the Saladin-le Chatelier galvanometer. The results show that Si raises the temperature of A_3 but diminishes its intensity until it disappears at about 2 % Si. Increasing Si-content lowers A_2 (10 to 12 deg. C. per 1 % Si) but raises A_1 until the two points combine at 3·16 % Si. At 3·94 % Si two points again appear, but at higher percentages (about 50 % Si) the upper point disappears. Microscopic and chemical examination indicate that above 3·2 % Si the positions of the points A_1 and A_2 are reversed, *e.g.* in the 3·94 % steel A_1 appears at 720° C. and A_2 at 690° C. In the higher alloys the point A_1 disappears owing to retention of the carbon in the graphitic state. The point A_2, however, is lowered continually with increasing Si. These results have been confirmed in a steel containing 0·85 % carbon. F. C. A. H. L.

1899. *Proposed Modification of the Iron-Carbon Diagram.* **A. Vinogradoff.** (Rev. de la Soc. Russe de Métallurgie, pp. 234–268, 1912. Rev. de Métallurgie, 10. pp. 493–494, Sept., 1913. Abstract.)—In the ordinary equilibrium diagram of the iron-carbon system the horizontal line MO at about 780°, marking the change from β to α, is argued not to represent all the facts satisfactorily. It is proposed to add another set of curves for temperatures below 500°, similar to those now adopted for the higher temperatures. In accordance with these suggestions, β iron dissolves iron carbide forming osmondite. Martensite (and troostite) are due to the uniting of the γ and β phases—represented by austenite and osmondite respectively. Sorbite is probably a eutectic of osmondite and cementite. F. R.

1900. *Hardening Hypereutectoid Tool Steel.* **S. S. Steinberg.** (Rev. de la Soc. Russe de Métallurgie, pp. 613–615, 1912. Rev. de Métallurgie, 10. p. 502, Sept., 1913. Abstract.)—Some tool steel which broke with a coarse fracture was found to have a cementite network, and reheating at various temperatures, followed by quenching did not cure the trouble. The steel was then quenched from above Ac_3 in boiling water, and again hardened, with good results. It is pointed out that, as would be expected, the first quenching serves to retain the cementite solution, which could not be attained by heating to the ordinary quenching temperature. F. R.

1901. *Cast Iron and Malleable Cast Iron.* **W. H. Hatfield.** (Rev. de Métallurgie, 10. pp. 937–948, Aug., 1913.)—The alloys of iron and carbon are discussed from the point of view of the phase-rule and the modern equilibrium diagram. Foundry cast irons and malleable cast irons are illustrated by photomicrographs and the principles underlying the conversion of white iron into malleable cast iron are described, due attention being paid to the actions of Si, S, P, Mn, etc., on the stability of the carbide. F. C. A. H. L.

1902. *Volume-changes in Quenching Steel.* **M. Oknoff.** (Rev. de la Soc. Russe de Métallurgie, pp. 616–631, 1912. Rev. de Métallurgie, 10. pp. 502–508, Sept., 1913. Abstract.)—Carbon steel quenched from above A_1 has a greater volume than the same steel before quenching. The increase of volume depends mainly upon the carbon-content, and increases with it and the speed of cooling. It is, however, practically independent of the quenching temperature between 700° and 1000°. Steels containing from 0·2 to 0·5 per cent. carbon, quenched at from 750° to 800°, have a slightly smaller volume than the same steels quenched from 700°. It is suggested that this is due to the presence of β-iron in the steels quenched at from 750° to 800°. In high-carbon iron-carbon alloys repeated quenching decomposes free cementite, resulting in erratic increases of volume which mask the increases that accompany hardening. F. R.

1903. *Over-oxidation of Steel.* **W. R. Shimer** and **F. O. Kichline.** (Amer. Inst. Mining Engin., Bull. No. 81. pp. 2361–2377, Sept., 1913.)—Oxygen estimations and photomicrographs are given for samples taken at various stages in blowing metal in the Bessemer converter for use in the Duplex process. The details of each heat studied should be noted in the original, but the principal conclusions at which the authors arrive are the following:—Efforts were made to obtain the greatest possible over-oxidation, by over-blowing and by the addition of ore. The highest oxygen contents attained by over-blowing were 0·074, 0·064, and 0·049 %, despite the fact that samples were taken at once and cooled promptly. By adding ore, after the blow, the greatest oxygen-contents obtained were 0·029, 0·028, and 0·038 %, the samples being taken as soon as the ore was melted into the slag. When time was allowed for the oxygen to escape after the ore addition 0·017 % of oxygen was found. The excess of oxygen disappeared in a very few minutes of standing, or was removed upon addition of molten mixer metal. The presence of a mixer skull in the bath, or over-oreing, resulted in excessive amounts of manganese silicate being present in the steel. A basic open-hearth cast made under extremely oxidising conditions gave only 0·024 % oxygen. The carbon was 0·05 %, and the sample was taken before adding the ferro-manganese. Results on steels as forged or cast were practically identical. The oxygen-contents of open-hearth rail steels ranged from 0·019 to 0·016 %; those of sections from 0·024 to 0·014, the carbon-content being about 0·019 %. It appears improbable that above 0·080 % oxygen can be obtained in ordinary Bessemer and basic open-hearth practice, after adding decarburisers, or over 0·075 under any circumstances. Results higher than these figures must therefore be due to oxidation during teeming or to imperfect drillings. The oxygen determinations were made by a slight modification of Ledebur's method, and some particulars of the investigation and of the details adopted are given. F. R.

1904. *Coefficient of Flow and its Importance during Casting in Metal Ingot Moulds.* **A. Portevin.** (Rev. de Métallurgie, 10. pp. 948–951, Aug., 1913.)—Among the various factors acting on the quality of metals and alloys cast into ingots, and one which is quite neglected in works on foundry practice, is the rate of casting or rate of flow of the metal in the mould. After pouring, the metal remains liquid in the mould for some time, solidification being ultimately propagated from the bottom to the top of the ingot; the length of time during which the metal remains fluid is determined by the rate of solidification, and has an important bearing on the quality of the metal produced. The velocity of solidification depends upon a large number of factors—on the temperature of fusion, specific heat, and latent heat of fusion of the alloy, on the dimensions, temperature, heat conductivity and specific heat of the ingot mould, on the conditions and temperature of casting, on the velocity of rise of the surface of the metal in the mould, and so on. The last-mentioned factor increases with the sectional area of the feeder and decreases with the sectional area of the ingot; to the ratio of these two areas the term "coefficient of flow" has been applied, and its best value determined for a number of copper alloys. It has been found to vary according to the nature of the alloy, the size of the ingot mould, and the material of which it is made. F. C. A. H. L.

1905. *Measurement of Electrical Quantities in Siemens Ozone Tubes.* **V. Ehrlich** and **F. Russ.** (Zeitschr. Elektrochem. 19. pp. 330–340, April 15, 1913.)—The measurements were made with the aid of a Dolezalek binant electrometer and a Gehrcke glow-light oscillograph; particulars of the arrangements are to follow. It results that the ionisation current and potential are always in phase; thus the potential across the gas-gap between the glass tubes is a measure of the energy consumption, and all means which reduce the minimum effective potential will increase the energy yield. The discharge was sent through dried air. H. B.

1906. *Neutral Oil Emulsion as a Model of a Suspension Colloid.* **R. Ellis.** (Faraday Soc., Trans. 9. pp. 14–25; Discussion, pp. 26–28, July, 1913.)—The interface potential at the surface of the oil globules of an emulsion was measured by means of a microscope slide apparatus. It was found to be little affected by organic impurities in the oil, but to be altered enormously by acids, and to a lesser degree by alkalies. The max. interface potential was found to correspond with a concentration of about 0·001-N alkali, and this was found to be the point of max. stability of the emulsion. Surface-tension measurements showed that the stability did not depend on the surface tension but on the interface potential. Determinations were made of the concentrations of salts with mono-, di-, and tri-valent kathions required to neutralise exactly the charge on the oil globules. The ratio of these concentrations was found to form a geometrical series agreeing with that obtained by coagulation experiments. The coagulation of oil emulsions by colloidal ferric hydroxide was next tried, and it was found that the oil was completely precipitated within two well-defined limits on either side of the iso-electric point of the oil emulsion. The coagulation appears to be due to surface precipitation effects, somewhat analogous to the condensation of water-vapour on surfaces of various curvatures, taking place between the oil globules. T. S. P.

1907. *Formation of Aluminium Nitride from Alumina, Coal, and Nitrogen.* **I. W. Fraenkel.** (Zeitschr. Elektrochem. 19. pp. 362–378, April 15, 1913.)—The furnace is of the F. Fischer type, being a glass globe with projections; the carbon tube to be heated forms a diameter together with the graphite cylinders into which it fits. The charge consists of an intimate mixture of soot and alumina in the ratio 1C : $2Al_2O_3$; it is compressed into pellets which are crushed. Temperatures were measured with a Holborn-Kurlbaum pyrometer. The formation of AlN begins with very finely powdered materials below 1400° C., and is brisk at 1500° C.; reduction of the nitrogen pressure from 1 to 0·33 atmos. had hardly any effect; the presence of CO is detrimental; the endothermic reaction is $Al_2O_3 + 3C + N_2 \rightleftarrows 2AlN + 3CO$. Alumina is easily reduced to the carbide Al_4C_3 by C and CO; this carbide sublimes and may disturb the observation; the carbide is possibly the intermediate product in the nitride formation. Different kinds of carbon (charcoal, coke, graphite) react with different velocities; this is being further investigated. H. B.

1908. *Dissociation Isotherms of Sulphur, Selenium, Arsenic, and Phosphorus.* **G. Preuner** and **I. Brockmöller.** (Zeitschr. Phys. Chem. 81. pp. 129–170, 1912.)—Employing a modification of the quartz-glass manometer described by Preuner and Schupp, the results obtained by these investigators for sulphur [Abstract No. 1045 (1910)] have been confirmed, and from the equilibrium $4CuS \rightleftarrows 2Cu_2S + S_2$ it is concluded that the conversion of 64 gm. solid rhombic S into gaseous S_2 molecules involves an absorption of 32,500 cals. Experiments with selenium, for which dissociation isotherms and vapour-pressure curves are given, show this to exist chiefly as Se_6 and Se_2 up to 900° C., at which temperature there are a small number of Se_1 molecules, while below 500° there are probably some Se_8. Gaseous Se_6 absorbs 55,960 cals. in passing into $3Se_2$. Dissociation isotherms of As and P are also given, the former being shown to exist as As_4, As_2, and As_1 molecules in the gaseous state between 600° C. and 1200° C., and the latter as P_4, P_2, and P_1 between the same temperatures. In the conversion of gaseous P_4 to $2P_2$ 31,500 cals. are absorbed, and P_2 molecules to $2P_1$ 45,500 cals. W. H. Si

1909. *Electrolytic Theory of the Corrosion of Iron.* **B. Lambert.** (Faraday Soc., Trans. 9. pp. 108–114, July, 1913.)—American writers have discussed the electrolytic theory of the corrosion of iron from the point of view of Nernst's conception, and it seems to follow from their reasoning that even chemically pure and physically homogeneous iron ought to rust in contact with air and deposit copper from its solutions. The author's experiments [Abstract No. 732 (1913)] have proved beyond all doubt that pure iron can be prepared which will not rust on prolonged exposure to air or water, and will not cause the deposition of copper from its solutions. It has been thought that any electrolytic theory of the rusting of iron must stand or fall on the question of the solubility of pure iron in pure water, but since the solution of a metal in an electrolyte depends upon the existence of p.d.'s and consequent flow of current it follows that a chemically pure and physically homogeneous metal cannot rust because there is no variation in solution pressure over the whole of its surface so that no p.d.'s can be set up. At the same time it also follows that the production of a coherent uniform coating on the surface of commercial iron would prevent rusting. Corrosion can be started in iron which does not rust by locally deforming it, when the deformed portion becomes electronegative. The behaviour of pure iron towards copper chloride solution is of interest since it cannot be predicted by the electrolytic theory. Pure iron which does not rust in water and does not precipitate copper from copper nitrate and sulphate solutions, immediately precipitates copper from copper chloride solution. A similar effect is brought about by adding chlorides of the alkali metals to solutions of copper nitrate or sulphate containing bright iron, or by heating sulphate solution to 100° C. Dilute solutions of the chlorides of the alkali metals have a remarkable effect in starting the corrosion of pure iron. The author considers that passivity is brought about by such materials as strong nitric acid or caustic alkalies having the power to destroy or seriously diminish the electrical differences which always occur in commercial iron, with the production of an "electrically equable surface." On the other hand, such materials as chlorides stimulate corrosion by increasing the electrical differences. F. C. A. H. L.

1910. *Potential due to Liquid Contact.* **A. C. Cumming** and **E. Gilchrist.** (Faraday Soc., Trans. 9. pp. 174–185, July, 1913.)—The authors' experiments lead them to the following conclusions:—(1) To obtain accurate measurements of potential it is necessary to form a new boundary shortly before the measurement is taken, otherwise a serious error may be introduced. (2) It is desirable that the two solutions should be mechanically mixed at the boundary, and this is the more important the narrower the tube in which the boundary is formed. (3) Capillary tubes should be altogether avoided in the construction of an electromotive cell. (4) The e.m.f. of any cell which derives part of its potential from the presence of a liquid contact is not constant, but varies with the time which has elapsed since formation of the boundary; if due attention is paid to the precautions mentioned above, consistent and comparable results may be obtained. L. H. W.

1911. *Measurement of Polarisation; Methodical Error.* **D. Reichinstein.** (Zeitschr. Elektrochem. 19. pp. 518–520, July 1, 1913.)—In his measurement of the chemical polarisation of the reversible electrode $Cu \mid Cu^{\cdot\cdot}$ the author had made use of a Pt-H_2-electrode, the siphon of which ended at the paraffined back of the electrode. F. Foerster having drawn his attention to the fact that this method was misleading, he continues his researches with the aid of the Haber-Luggin capillary. He further points out that a real alloy will, when not under current, have practically the potential of the principal metal, which metal will alone be dissolved with anodic polarisation. Such an alloy will show the properties of a reversible electrode in an accentuated degree. H. B.

1912. *Chemical Polarisation of Reversible Electrodes. Anodic Behaviour of the Alloys Hg-Cu and Ag-Cu.* **D. Reichinstein** [Experiments with **A. Bürger.**] (Zeitschr. Elektrochem. 19. pp. 520–530, July 1, 1913.)—The author distinguishes between positive depolarisation (when the addition of the depolariser increases the current intensity) and negative depolarisation (when the current intensity is decreased). The depolarisation is due not to a difference in the equilibrium potentials of two systems, but to special kinetic conditions; the mechanism is somewhat as in auto-catalytic reactions. The anodic dissolution of a reversible electrode is of the nature of a negative depolarisation. The experiments concern the current density-potential curves and the time-potential curves of anodically polarised electrodes, Cu | $CuSO_4$, Cu-Hg | $CuSO_4$, Cu-Ag | $CuSO_4$, in the presence of H_2SO_4. Primary copper-ions are formed as the formation of the alloy Hg-Cu proceeds; the pure copper electrode itself behaves qualitatively like a real alloy of Cu-O. H. B.

1913. *Overvoltage.* **J. W. Richards.** (Faraday Soc., Trans. 9. pp. 140–141, July, 1913.)—The author regards overvoltage as due to increased surface resistance caused by the adhesion of gas to the metal. Support of this view he finds in three experiments made with sulphuric acid cells and smooth electrodes of Pt, Au, or Ni, the cell being treated as a calorimeter. H. B.

1914. *Electrolytic Valve Action of Niobium.* **U. Sborgi.** (Gazzetta Soc. Chim. Ital. 42. 2. pp. 331–345, 1912.)—The anodic behaviour of niobium in various electrolytes is found to depend on its degree of compactness, a momentary current being produced in most electrolytes with an anode of incompact Nb, but no current passing when a compact block of Nb is used. It is concluded that the anode becomes covered at the commencement of electrolysis, with a layer which hinders the passage of ions, its degree of impermeability varying in different electrolytes. Niobium differs from ordinary passive metals in these respects, and also in dissolving when a current passes. [See also Abstract No. 1019 (1908).] W. H. Si.

1915. *The Form of Electrolytically Deposited Metals.* I. *Black Silver.* **V. Kohlschütter** and **T. Toropoff.** (Zeitschr. Elektrochem. 19. pp. 161–168, Feb. 15, 1913.)—Silver black differs from other black metals. It can be obtained by the action of organic reducing agents and of Zn, Cu, Cd on solutions of silver salts, and further by electrolysing diluted solutions at high current density. However prepared, black silver cannot be isolated as such, because it changes into the grey or white crystalline metal; the change sets in as soon as the current is interrupted, and takes place more rapidly in acid and also in alkaline solutions than in pure water. Itself crystalline and yet colloidal, the black silver seems to be in a state intermediate between the colloidal and the crystalline states. The crystallisation is studied with the aid of potential measurements on small kathodes and large anodes. The formation of black silver occurs when the very diluted solution at high-current density is, so to say, supersaturated with silver atoms near the small kathode. The sudden change on stopping the current is supposed to be an electrostatic phenomenon.

II. *Silver Deposited by Metals.* **V. Kohlschütter, T. Toropoff,** and **W. Pfander.** (Ibid. pp. 169–172, Feb. 15, 1913.)—The appearance of the silver depends upon the concentration of the solution, on the rate of precipitation by the metals studied, Cu, Zn, Cd, Fe, Sn, Al, Mg, and upon their chemical behaviour. The addition of salts to the silver nitrate, strange to say, accelerates the deposition. When copper is placed in silver nitrate and some neutral copper sulphate is added, colloidal copper hydroxide is formed by hydrolysis and adsorbed by the copper, whose solution is thus retarded; but in the presence of the electrolyte the colloidal film is either dissolved or coagulated. The colloidal hydroxide has, however, some influence on the crystallisation of the silver.

III. *Influence of Foreign Substances on the Deposition of Silver.* **V. Kohlschütter** and **H. Schacht.** (Ibid. pp. 172–181. Feb. 15, 1913.)—When the ammoniacal solution of silver nitrate contains also small quantities of salts (nitrates) of Cu, Zn, Cd, Pb, Be, Cr, Al, Tl, colloidal hydroxides are formed which affect the silver electrolytically deposited, as is demonstrated by photomicrographs. Strangely enough, the silver deposits are, as a rule, heavier than they should be, apparently because silver is also precipitated chemically, not only electrolytically; compounds of the other metals are also found in the deposit, but only in traces. The hydroxide films on the kathode act as filters which influence the distribution of the germs or centres of crystallisation.

IV. *Electrolytic Deposition of Silver from Complex Salt Solutions.* **V. Kohlschütter.** (Ibid. pp. 181–184, Feb. 15, 1913.)—Complex (cyanides, thiosulphate, oxalate, etc.) solutions deposit in the first instance colloidal "subhaloids" or "photo haloids" of reddish-violet or blue-grey colour. This deposit forms a skin or film which changes its colour into silver-white when it is washed with water, especially in faintly alkaline solutions. When the electrode together with the skin is washed and immersed in ammoniacal silver nitrate, the silver is deposited as a coherent adhesive layer on the skin, as if the solution were still of the complex character. If the silver kathode is itself dissolved in nitric acid, the skin or film remains intact, and silver will be deposited on it again in the compact form, not in crystal groups. The experiments do not suffice to explain the phenomena. H. B.

1916. *Electrolysis of Nitric Acid Solutions of Copper.* **J. H. Stansbie.** (Faraday Soc., Trans. 9. pp. 11–18, July, 1913. Chem. News, 106. p. 288, Dec. 13, 1912.)—The author's experiments were made with the object of finding the cause of the failure of the electric current to deposit copper completely from nitric acid solutions of the metal. It was found that when a Pt kathode, thickly plated with copper, was rotated in a solution of nitric acid containing less than 0·1 mgm. of copper, no current being passed, much less copper was dissolved than when the electrode was stationary. In the latter case the nitrous acid or nitrite accumulates in the neighbourhood of the copper and thus exerts its solvent action. In experiments on the deposition of Cu from nitric acid solutions the amount of Cu left in the solution was found to increase with the concentration of the nitric acid and with the accumulation of nitrous acid in the solution. The presence of free sulphuric acid in the solution prevents the formation of nitrous acid, and hence its beneficial effect on the quantitative deposition of Cu from solutions containing nitric acid. T. S. P.

1917. *Passivity of Metals and its Dependence upon the Solvent.* **N. Isgarischew.** (Zeitschr. Elektrochem. 19. pp. 491–498, June 15, 1913.)—The experiments were made by taking potential measurements of various metals—Ni, Co, Fe, Cd, Cu, Zn—in their salts dissolved in alcohols or in water. The nickel, *e.g.* was tested in nickel chloride; the potential rose, went back to its original value on removing the nickel (when the electrode was taken out of the bath and cleaned), rose more rapidly again on second immersion, and so on. When all the oxygen had been removed from the electrolyte and hydrogen was passed through it while taking measurements, the potentials did not rise. The rise of potential or passivity is hence ascribed to the formation of an intermediate soluble product, probably a peroxide. Copper seems to form a complex compound containing its chloride and alcohol of the formula $Cu . (C_2H_6O)_2 . CuCl_2$. H. B.

1918. *Tantalum as Kathode Material.* **G. Oesterheld.** (Zeitschr. Elektrochem. 19. pp. 585–587, Aug. 1, 1913.)—O. Brunck having recommended kathodes of tantalum, which is not attacked by aqua regia and caustic alkalies, the author investigates its behaviour in electrolysis. The metal foil loses its elasticity and strength in a few hours in alkaline and acid solutions, because it readily adsorbs hydrogen, and 0·1 per cent. of hydrogen is sufficient to change the structure of tantalum. Comparison experiments were made with palladium. H. B.

1919. *Influence of Colloids on the Electrolysis of Metallic Salts (Lead and Zinc).* I. **R. Marc.** (Zeitschr. Elektrochem. 19. pp. 431–444, June 1, 1913.)—The colloids added in small quantities are gum arabic, starch, albumin, and gelatin, the salts the acetate, formate, benzoate, salicylate and silicofluoride of lead, and the acetate and silicofluoride of zinc. Both the kathode and the anode products are studied. All the colloids tend to produce a finer grain of the kathode deposit, but the coherence may be improved or deteriorated: two effects oppose one another. A coherent layer requires high elasticity and small grain; but a pure solution generally confers the former, not the latter property, and where there is a tendency to form large crystals, the addition of comparatively large amounts of colloids leads to brittleness. Brownian movements were observed in the case of lead crystals of unusually large dimensions, 15 by 2 μ, but extremely thin, when colloids were present, not in pure water; this persistence of Brownian movements was also observed with barium and strontium salts (sulphate and carbonate), in the presence of colloids. At the kathode the presence of colloids always favoured the liberation of hydrogen; their influence upon the reactions at the anode was complex, lead peroxide being deposited, oxygen liberated, or incrustations of organic compounds being formed. Photographs of characteristic deposits are reproduced in the paper. H. B.

1920. *Electrolytic Separation of Tin from Tungsten.* **W. D. Treadwell.** (Zeitschr. Elektrochem. 19. pp. 381–384, May 1, 1913.)—Having reviewed the chemical methods, the author shows that tin may be electrolytically deposited from solutions in sodium sulphide; ammonium sulphide is not advisable because the deposit is contaminated with sulphur and may contain up to 2 mgm. of Pt. Even in the former case some sulphide is always found in the deposit, and the current should be interrupted a few mins. after the precipitation of the tin may be assumed to be complete. Any Mo present would fall together with the tin; when oxalic acid is used as solvent, W would also go into the deposit. The electrolytic separation, particulars of which are given, is much more expeditious than gravimetric methods. H. B.

1921. *Electrochemical Production of Colloidal Copper.* **T. R. Briggs.** (Journ. Phys. Chem. 17. pp. 281–319, March, 1913.)—The general results are the following:—(1) Schützenberger's "allotropic" copper is a solid gel of normal copper in a finely-divided form, analogous to similar forms of lead, silver, and gold. (2) The electrolytic production of a new form of colloidal copper by the electrolysis of certain copper solutions containing gelatine is described in detail. (3) The remarkable colour action shown by these films of gelatine-copper has been studied and is termed a development. (4) Electrolytic methods have been devised for colouring objects of copper and other metals a variety of hues, the more prominent being blue, red, and gold.

L. H. W.